International Civil Aviation Organization

Fourth ATN Transition Task Force Meeting

Mumbai, India, 8-12 April 2002

Agenda Item 3: Review ATN technical documents and transition issues.

TECHNICAL DOCUMENT ON ATN PERFORMANCE PROPOSED RCPS

(Presented by Japan)

SUMMARY

The paper provides a technical documentation on the ATN Performance. The Part I provides survey, definition and procedures on the ATN Performance and Part II provides an example of the ATN

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Related References

[1] ATN Guidance Materials; Sub-Volume x
ATN SYSTEMS MANAGEMENT SERVICES (2.)
ATN Systems Management Requirements(2.2)
Performance Management Requirements(2.2.2)

[2] RTCA SC-189/EUROCAE WG-53 SG3/PP(Position Papers)

[2-1] PP3 Methodology for Determining Required Communication Technical Performance.
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[2-3] PP9 Methodology for Allocation of Performance Requirements and Consolidation of Installed Performance.
[2-4] PP11 COMMUNICATION PERFORMANCE TEMPLATE
[2-5] PP16 COMMUNICATION PERFORMANCE OPERATIONAL CONCEPT

[3] OPLINK Panel Manual on Required Communication Performance

[4] AN-WP/7666 AIR NAVIGATION COMMISSION
ANC Task No. ATM-9502: ATM requirements for communications
PROGRESS REPORT ON THE DEVELOPMENT OF AN OPERATIONAL CONCEPT OF REQUIRED COMMUNICATION PERFORMANCE (RCP)
(Presented by the Director of the Air Navigation Bureau) 31/5/01

[5] RTCA DO-264

[6] RTCA DO-274

[7] EUROCAE/RTCA WG-53/SC189/SG6 Operational Performance Assessment

‘CNS/ATM Operational Performance Asssessment of ATM systems using data link communications.’, Jan. 2001

Part I Survey, Definition and Procedures of the ATN Performance

1. Introduction

The part provides the general information (survey, definition and procedures) on the ATN Performance to be planned, installed and operated in the Asia/Pacific region. In order to focus our attentions and give a clear understanding on performance, the subject is divided into three sub-topics.

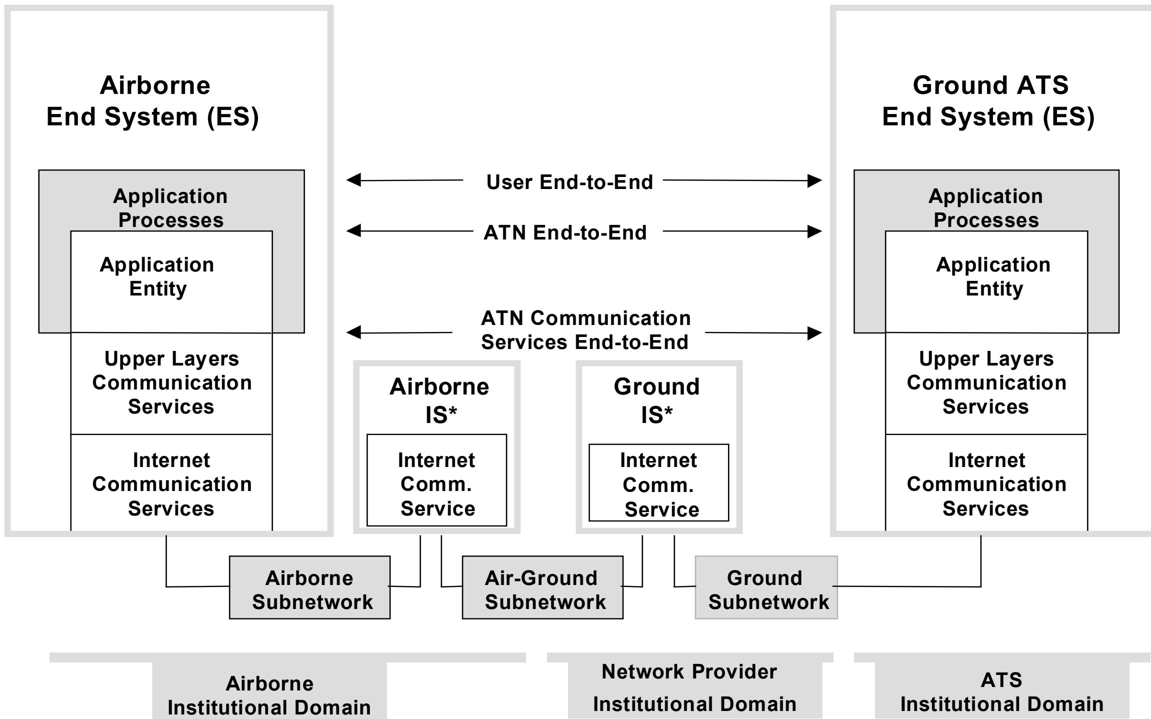
(1) It has to be clear what is meant by the ATN performance, and what kind of parameters are needed to characterize the ATN performance,
(2) In order to achieve any specific performance, it is necessary to facilitate how the requirements are defined and stated in the planning phase, after that ,
(3) It is also important how the stated requirements are implemented in the development phase, and managed during the operational phase.

2. Performance Definitions

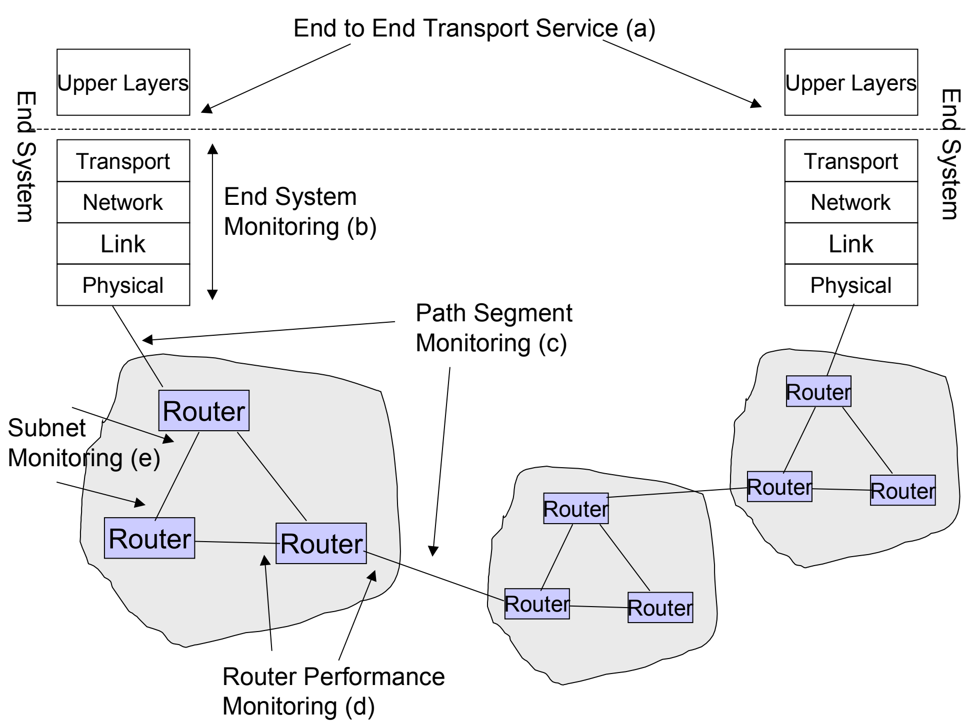
It is hard to define the 'Performance' in one sentence. This leads to define the scope of the 'ATN Performance' then introduce the parameters characterizing the ATN performance.

2.1 Scope of ATN performance

The ATN is defined in various documents. The ATN has various components, hence there is a requirement that the ATN performs as a whole. First of all, it is important to identify the scope of the ATN, and then the components of the ATN. The following figure shows an example of the A/G ATN context [2-2]. There are Airborne ES, Airborne IS, Ground IS (Air-Ground IS) and Ground ES in the A/G context. There are also similar components in the G/G communication context, which are identified in the various ATN documents. In the figure, the communication domains are mentioned, where there is no agreement so far what is the communication domain, that is, the functional domains and institutional domains are not same.



The another figure shows the ATN scope and components from the monitoring view-point of ATN performance management [1].



The ATN performance is considered to be a communication performance, although it may not be exactly same where the ATN includes some 'ATN applications'.

Moreover what is meant by communication in the ATS environment has more than one interpretation. This leads to the two Communication Concepts; Operational Communication Concept[3] and Technical Communication Concept[2-1].

Another consideration on Communication is whether the communication is one-way or two-way in the ATS environment [3]. If it is two-way, there is a question whether it includes the human part in the communication loop.

2.2 Parameters of ATN performance

Again, there are various sources of the ATN Performance parameters; although these parameters are similar (but not the same). The following table shows the communication performance parameters [1].

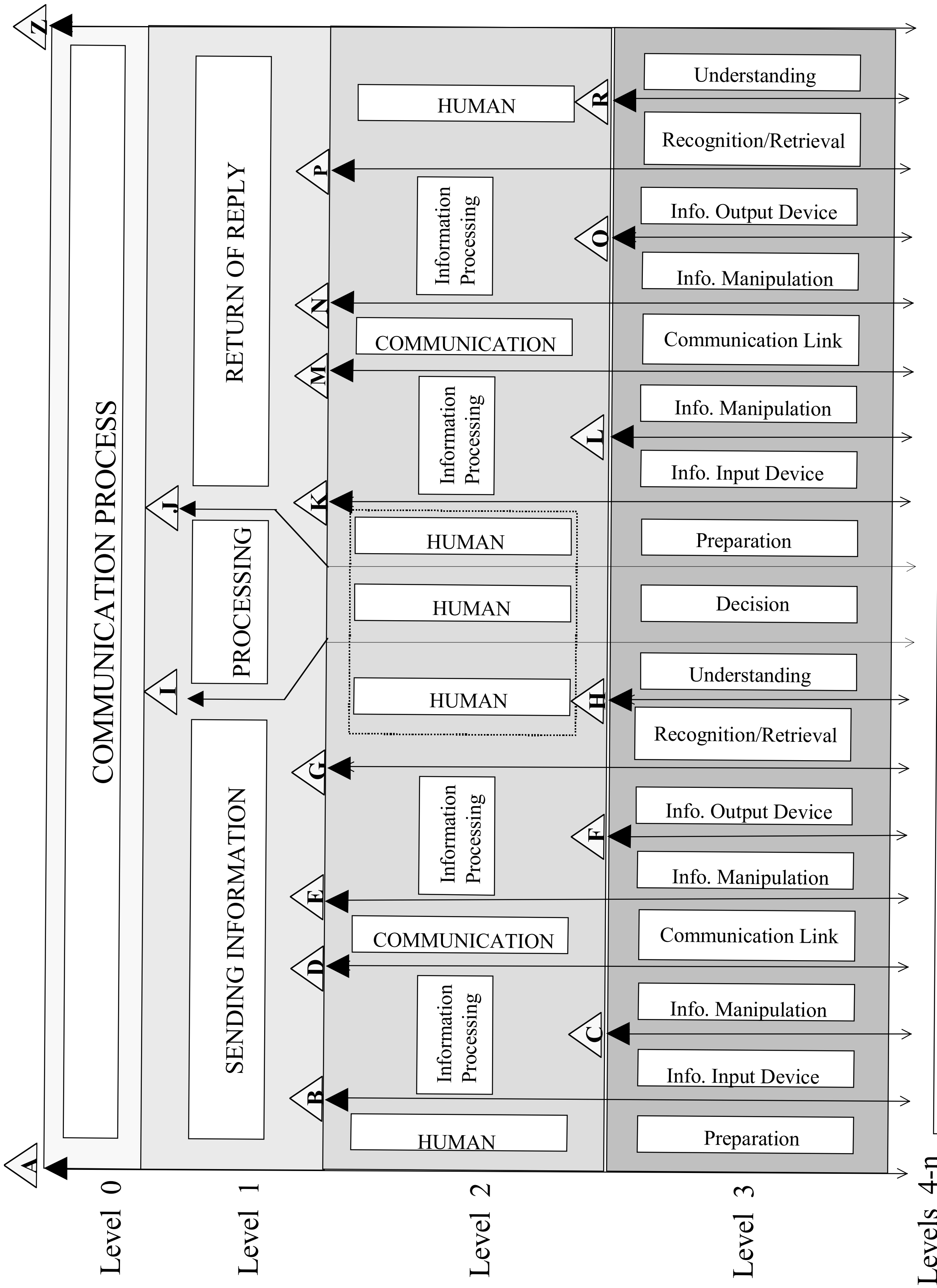


Figure 1 - The Overall Communication Process

	Parameters	Definitions
1	Availability*	"The ability of a system to perform its required function at the initiation of the intended operation. It is quantified as the proportion of the time the system is available to the time the system is planned to be available".
2	Reliability*	"The probability that the system will deliver a particular message without errors."
3	Continuity*	"The probability of a system to perform its required function without unscheduled interruptions during the intended period of operations."
4	End-to-End Transfer Delay*	"The period elapsed from the time at which the originating user initiates the triggering event until the time the transmitted information has been received by the intended recipient."
5	Integrity*	"The probability that errors will be mis-detected. This may be when a correct message is indicated as containing one or more errors, or when a message containing one or more errors is indicated as being correct."
6	Throughput	"The quantity of data (e.g. measured in characters) that can be sent during a given period."
7	Connection Establishment Delay	"The time from initiating an end-to-end connection to its successful establishment (i.e. when messages can be sent)."

* taken from ADSP(OPLINKP) Manual of ATS Data Link Applications

Although the definitions shown above may have the same meaning, the actual values of the parameters may differ, for instance 'Transfer Delay' may be the 'max' value or 95 percentile value.

Another set of performance parameters are defined somewhere else. See for instance [2-2] which is given in Appendix to Part I.

In this document, we adopt the parameters shown in the following table [7].

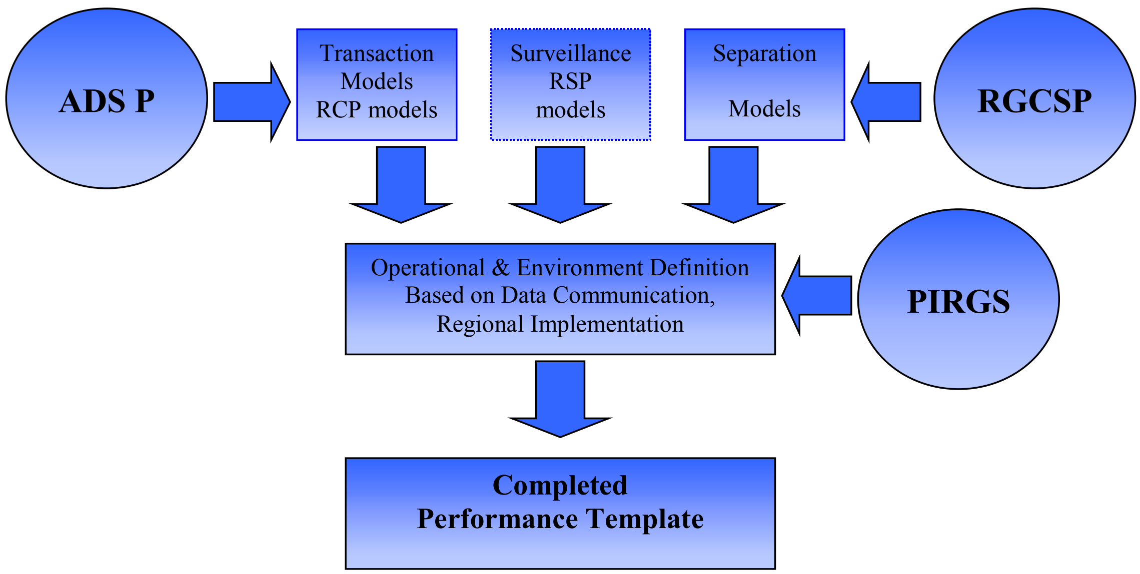
	Symbol	RCP Parameter Name	Descriptions
1	TT_{95}	95% transaction time	The time for which 95% of the transactions are completed. This is the time at which controllers and pilots can nominally accept the system performance and represents normal operating performance. Similarly, the 95% human response time represents the time that a human needs to perform a response 95% of the time. The starting point is at the instance when the *originator* hits the send button on the HMI. The end point is at the instance when the *originator* has received an operational reply on the HMI.
2	ET_{RCP}	Transaction expiration time:	The maximum time to complete a transaction, after which peer parties revert to an alternative procedure such as a "revert to voice procedure" or specific functions of the system are applied; Note: When the expiration time is exceeded, an alert is necessary to invoke the alternative procedures. The rate at which a transaction expiration time can be exceeded is determined by the continuity parameter. Note: The transaction time distribution is characterized by the transaction expiration time and 95% transaction time.

3	TD_{95}	95% Transit Delay	Time before which 95% of the transactions are completed. This is the time at which controllers and pilots can nominally accept the system performance and represents normal operating performance. The starting point is at the instance when the *originator* hits the send button on the HMI. The end point is at the instance when the *originator* has received an operational reply on the HMI. Editing Note; The description above is extracted from [7]. where it is same as TT_{95} above. The following description would be the correct one. *Time before which 95% of the* <u>*transmissions*</u> *are completed.* *The starting point is at the instance when the originator hits the send button on the HMI. The end point is at the instance when the* <u>*recipient*</u> *has received a message on the HMI.*
4	TH_{95}	95% Human response Time:	Time that a human needs to perform a response 95% of the time. The starting point is at the instance when the intended *recipient* has received and displayed a message. The end point is at the instance when the same *recipient* sends the response back to the initiator.
5	C_{RCP}	End-to End Continuity	The probability that the transaction will be completed before the transaction expiration time, assuming that the communication system is available when the transaction is initiated. It represents the probability of loosing a message: the transaction is initiated correctly, but it is never delivered to the end user due to an event. A loss of continuity can have human (e.g. pilot or controller is doing something else) and/or technical causes.
6	A_{RCP}	End-to End Availability	The probability that the communication system between the two parties is in service when it is needed.
7	$A_{provision}$	End-to-End Availability	Probability that communication with all data link equipped aircraft in the area is in service. *Note:* Practically speaking, the availability of the system does not depend on the type of information to be transmitted.
8	I_{RCP}	End–to-End Integrity	The probability that the transaction is completed with an error undetected by the system (bit or packet errors) or by the human (typing errors).

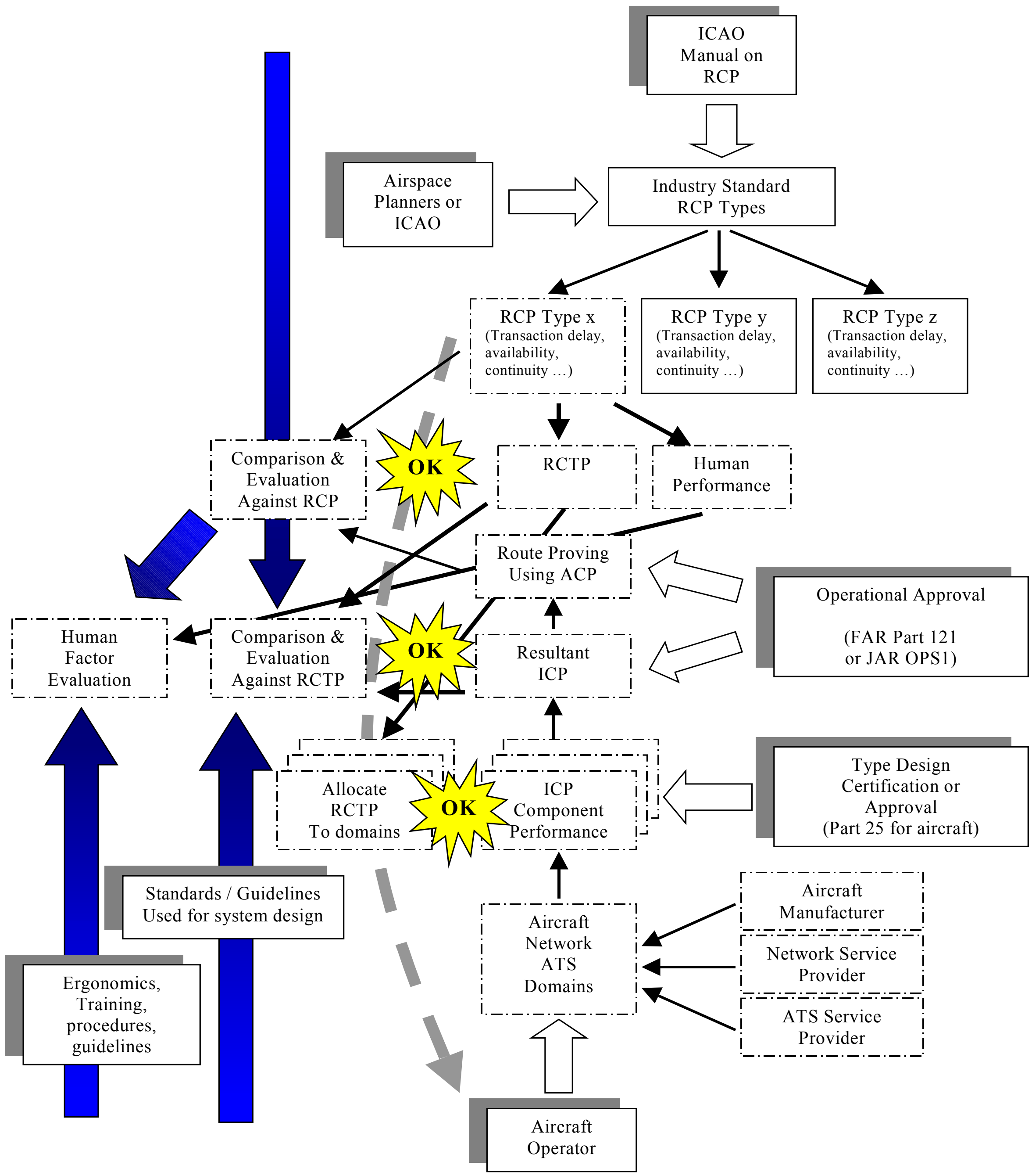
3 Stating Performance Requirements

What is expected for PIRGs to define and state requirements prior to the ATN Communication implementations? The following figure suggests a decision flow on the requirement statements [2-4].

3.1 How the ATN Performance Requirements can be derived



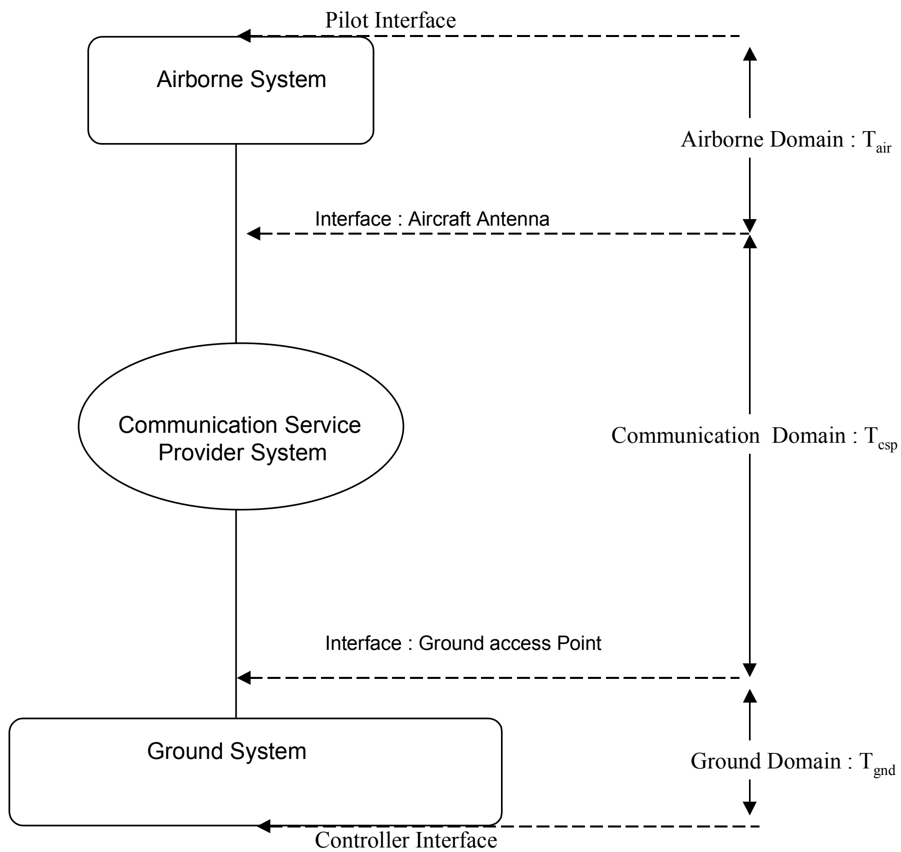
The ICAO Panels (OPLINKP, RGCSP, and so forth) would develop the RCP models and others which give a framework for PIRGs to clarify the environments and operations based on data communications in the region for defining the requirements on data communications. What have to be taken into considerations for defining the requirements? For the environment considerations, the characteristics of airspace are influential, and the (operational) services (e.g. separation service) provided also affect the requirements. It is suggested to develop Performance Requirements for each environment identified ,where data link application is used, together with the associated services in the environment. The following flow diagram suggests another detailed decision flow of the requirements [2-5].



Note: The meanings of RCP (Required Communication Performance), RTCP(Required Technical Communication Performance), ICP(Installed Communication performance) and ACP(Achieved Communication Performance) are given in [2-5].

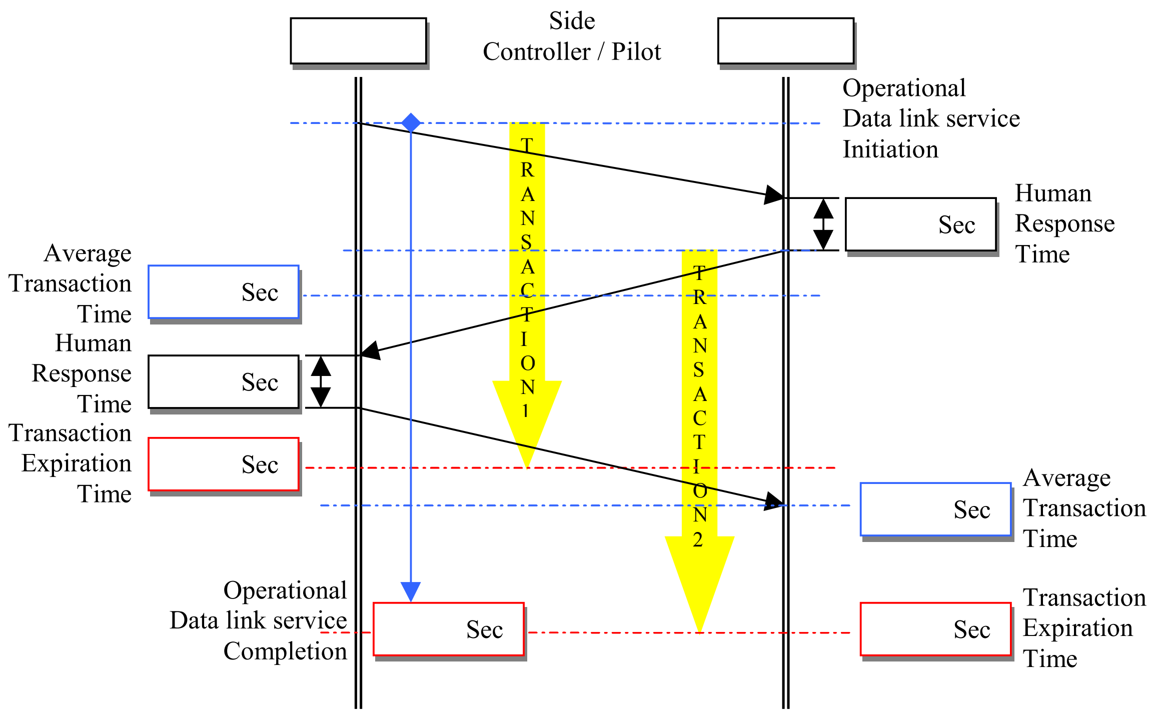
One important decision in the suggested flow is the determination of RTCP (Technical requirements on communication performance), that is, the gross (operational) performance requirements have to be budged to the (technical) requirement of each component along the communication path.
The following allocation is proposed in [7].

The transit delay is computed as follows: $TD_{95} = T_{air} + T_{csp} + T_{gnd}$



3.2 How the ATN Performance Requirements can be stated

It is also important to decide how the requirement statements can be stated. It is preferable to give a Performance Statement template to be completed. A part of such a template is extracted from the document [2-4].



The template is structured to provide information on an environment, where data link application is used, and services where the required performance is described in terms of the Performance parameters' values.

3.3 Summary

If a PIRG plans to provide data link applications for some areas and services in the Region,
(1) the environment has to be identified;
(2) the operational services(e.g. separation service) provided in the environment has to be identified.

For such an environment/service, the Performance Requirements have to be developed. Although such Performance Requirements are developed by the PIRGs, the requirements shall be compatible among the PIRGs, which implies that the coordination among the PIRGs is needed. After the development of Performance Requirements, it has to be broken down to a kind of the RTCP (Required Technical Communication Performance) where the performance of each component within a system can be planned, implemented, monitored and improved. Although a planning process is suggested in a figure of section 3.1, it is not clear that APANPIRG would follow the suggested process. Again, the suggested process implied the wider coordination beyond the PIRGs, namely various private sectors in the aviation community.

4. Management of Performance

The management consists of a series of activities; plan, do, see and act.

The first phase of (performance) management is ‘planning’, where the previous chapters provided such information.

The second phase is the implementation phase.

The third phase is the ‘monitoring’ phase, and the fourth is the ‘correcting/improving’ phase. These two phases are the operational phases.

The ATN guidance materials [1] give the following guidance in the third and fourth phases shown above;

The definition of Performance Management is;

> *Performance management enables the behavior of resources in the OSI Environment and the effectiveness of communication activities to be evaluated.*
> *Performance management includes functions to:*
>
> *1. gather statistical information;*
> *2. maintain and examine logs of system state histories;*
> *3. determine system performance under natural and artificial conditions; and*
> *4. alter system modes of operation for the purpose of conducting performance management activities.*

Along the line of definition, fifteen objectives are listed as follows;

	Objectives
1	End User QoS Measurement
2	End System(Lower Layers) Monitoring
3	Subnetwork Service Monitoring
4	Measurement of Path Segment Performance
5	Monitoring for Excess Capacity
6	Planning Future Capacity
7	Dynamic Capacity Management
8	Router Forwarding Measurement
9	Router Key Parameter Measurement
10	Measurement of Route Convergence Times
11	Air/Ground Router Overhead Measurement
12	Analysis of Data Stream Performance
13	Monitoring of Service Provider Compliance by Aggregate Data Flow
14	Monitoring of User Message Delivery
15	Monitoring of User Message Transfer Times

These objectives are kinds of routine tasks in the operational phases of the system.

Appendix to Part I
Communication Performance Parameters Definition by RTCA SC-189/EUROCAE WG-53 SG-3 [2-2]

1. Transaction time

The transaction time parameter defined for RCP is the 95% time, meaning 95% of the delivered messages fall within the specified value. When Installed Communication Performance (ICP) is determined for a communication path, transaction time for a statistically significant sample must be measured and then the statistics for the variability of that time applied in order to determine what the actual 95% time is for the communication path. This section defines the times within the system. Whether the functional domain definitions are used or the institutional domain definitions are used, the collective transaction 95% time represents the complete communication path.

There are environmental conditions which will effect transaction time. Some of these conditions are message length, message traffic density, and aircraft traffic density. These characteristics must be stated as qualifying assumptions to support the imposition of a specific 95% time requirement.

A transaction expiration time should be specified either linked to the transaction time defined for RCP. In all cases, it represents a time interval after the originator sends the message after which the message shall not be considered as applicable, even if it is subsequently received by the recipient

1.1 Transaction time

A transaction is defined as a communication between two humans (controller and pilot, pilot and pilot, or controller and controller). The start of the transaction is determined at a point in time when the human initiates a request. The completion of a transaction is determined when the originator receives the operational response and can act appropriately on that information (standing by is considered an action). Transaction time includes all aspects necessary to complete the communication, including forwarding of the message, return of the acknowledgement, and human interaction.

Total transaction time includes the time needed to transit the institutional or functional domains in both directions and the human factors time between the receipt of the original message and return of the operational response. However, since RCTP excludes the human factors time, the equation below also excludes this component.

The specification of the 95% transaction time and the message expiration time leads to the definitions of fault-free performance and faulted performance. The determination of 95% transaction time and message expiration time for a specific ATC service is described in the Methodology position paper (SG3PP3).

Fault-free performance has two categories:

- Normal – when the transaction time is less than the 95% time
- Rare Normal – when the transaction time is above the 95% time but less than the expiration time

Faulted performance occurs when the transaction time is equal to or greater than the specified message expiration time.

1.1.1 Transaction times in the Functional Domains

If the functional domains are used in order to determine times, the following subsections give an example of how transaction times in the three functional domains are defined.

1.1.1.1 Airborne Application Domain Transaction time (t_{air})

For a downlink transmission, the Airborne Domain transaction time starts when a crew action or an automatic trigger is detected. The Airborne Domain transaction time ends when the airborne system *attempts to deliver* the message to the Network Domain.

For an uplink transmission, the Airborne Domain transaction time starts when the Network Domain attempts to deliver the message to the Airborne Domain. The Airborne Domain transaction time ends when the message is available to the pilot or to the end system automation.

Note 1: *Attempts to deliver* (for downlinks) is defined as when the protocol Request to Send, or equivalent, is sent to the Network Domain.

Note 2: *Attempts to deliver* (for uplinks) is defined as the time when the protocol Request To Send, or equivalent, is sent by the Network Domain.

1.1.1.2 Network Domain Transaction time (t_{net})

For a downlink transmission, the Network Domain Transaction time starts when Airborne Domain attempts to deliver the message to the Network Domain. Refer to Note 3 for definition of *attempts to deliver*. The Network Domain Transaction time ends when the network modem or adapter attempts to deliver the message to the ATS Domain.

Note 3: Since the protocol between the Network point of attachment (e.g. modem or adapter) and the ATS Domain is unknown (by Sub-group 3), an exact definition of "attempts to deliver" from the network point of attachment is not possible at this time. However, one must recognise that the different definitions will generate differences in measurements which will be insignificant (say fractions of a second) when compared to the allocated requirement (say tens of seconds).

For an uplink transmission, the Network Domain Transaction time starts when the ATS Application Domain attempts to deliver the message to the point of attachment of the Network domain (see also Note 5). The t_{net} ends when the Network Domain attempts to deliver the message to the Airborne Application Domain. Refer to Note 4 for the definition of *attempts to deliver*.

1.1.1.3 ATS Application Domain Transaction time (t_{ats})

For a downlink transmission, the ATS Application Domain Transaction time starts when the Network Domain attempts to deliver the message to the ATS Application Domain. The ATS Application Domain Transaction time ends when the information is available to the controller or available to the system automation.

For a uplink transmission, the ATS Application Domain Transaction time starts when a controller action or an automatic trigger is detected. The ATS Application Domain Transaction time ends when the ATS Application Domain attempts to deliver the message to the Network Domain.

1.1.2 Transaction times in the Institutional Domains

If the functional domains are used in order to determine times, a similar definition of the times in each of the institutional domains must be specified.

2. Availability

2.1 Link Availability

Link availability is defined as the ratio of *cumulative* time that messages can be exchanged between one pair of end users to the total required operating time that a path is required. The communication path is not available during two conditions. When a) messages sent over the communication path are rejected because of an outage of a component of a domain or b) when the communication path does not allow messages to be sent or received.

An end system will not allow a message to be sent under certain conditions. (e.g., for FANS 1/A, ACARS "NOCOM" or "FAIL" state). Equipment failures are one cause of this state.

2.2. Transaction Continuity

Transaction continuity is the availability of the communication system over the duration of the transaction (i.e., within the transaction expiration time) assuming the communication system was available at the initiation of the transaction. A transaction is a complete communication sequence, comprised of all elements necessary to forward, acknowledge, and respond, including the human factor time. Continuity is not affected by any scheduled interruptions.

2.3. Other Availability Considerations

Availability may be considered from the aircrew standpoint or from the controller standpoint.

From the controller standpoint, the consequences of total system un-availability are more significant since no ATS datalink service may be provided to any aircraft in the area of control. Only a loss of ATS System Domain availability or Network Domain availability can cause this event. Therefore, there is a higher availability requirement for these domains.

3. Message Integrity

Message integrity is a measure of the confidence that a message that is received is actually what was sent. Integrity risk is expressed as the probability of an undetected system-induced failure of message transmission (i.e., undetected message error) per flight hour.

The end systems must ensure that the end-to-end integrity requirements are satisfied for ATS communication supporting safety of flight .

Note 10 : For example, integrity of the FANS 1/A implementation is based upon an ARINC 622 CRC which is embedded in and checked by end systems which must meet the required level of development integrity.

Note 11: While it has been recognised that there are other error checking and correcting methods used within the various portions of the communication path, the integrity of the path has only been based on the error checking within the end systems because they are the only ones implemented by certified software (at least that is true of the airborne end system for FANS 1/A aircraft). There are issues which require further investigation; such as, what is the effect of error checks which cause increased times? what might be the credit associated with error checks which are implemented with certified software between the end systems?

Note 12: In the definition of RNP, the term 'integrity' is used to measure the confidence that the navigation system will detect and alert the condition where the system accuracy is outside its prescribed limits. It has been suggested that the 'integrity' specified for RCP could have a corresponding definition with respect to whether transaction time is within its prescribed limits. However, in data communications parlance, 'integrity' is a measure of the confidence that a message that is received is actually what was sent. It is this definition which is used in this position paper.

4. Other parameters

The following parameters are not included as elements of RCP, however, they may effect communication system performance.

4.1. Time Accuracy

Time accuracy is defined as the instantaneous difference between UTC and the time reference used by a system.

4.2. Priority, Preemption, and Precedence

Priority, preemption, and precedence are methods of improving Transaction time when there is congestion.

Each domain should give priority to safety related communications over non-safety communications in case of a problem with transaction time due to capacity limitations, however, priority is not a performance parameter.

4.3. Address ability

This parameter must be discussed by the interoperability subgroup. It is not a performance parameter.

PART II Sample Proposal: ATN Performance Requirements Determination

1. Introduction

This part provides the sample RCP for the ATN.
There are two documents related to the RCP; RTCA DO-274 and RTCA/ EUROCAE SG position paper [6],[7]. These two documents have different objectives for specifying the RCP.
RTCA DO-274 described the communication services in the voice and data communication environment (NEXCOM), while RTCA/ EUROCAE SG position paper [7] describes the communication services defined in the data communication environment (ATN). In the paper, we summarize the RCP descriptions of both documents. The reason why we adopt the RTCA/ EUROCAE SG position paper [7] is that the position paper addresses the data communication RCP and the first attempt to give some specific values of the RCP parameters, although it is still subject for discussions.
The reason why we adopt the RTCA DO-274 is that it covers all ATS communications in data as well as voice, where the latter may be using data communication in future.

2. Communication Scenarios and Corresponding Operational Timing Performance

2.1 Communication Services; RTCA/ EUROCAE SG position paper[7]

2.1.1 Communication Scenarios; RTCA/ EUROCAE SG position paper[7]

1) DLIC service

This service shall be a prerequisite for all datalink services.
DLIC provides the necessary information to enable data link communications between ground and aircraft systems, for applications such as ADS, CPDLC and D-FIS. DLIC provides information such as airframe identification, aircraft identification, available air applications, departure airport, destination airport, and estimated time of departure.

2) ACL service

An aircraft under the control of an ATSU transmits reports, makes requests, and receives clearances, instructions and notifications. The ACL service describes the dialogue procedures to be followed to perform these exchanges via air-ground data communications. The ACL service can be used within the en-route, terminal area environment or on the surface.

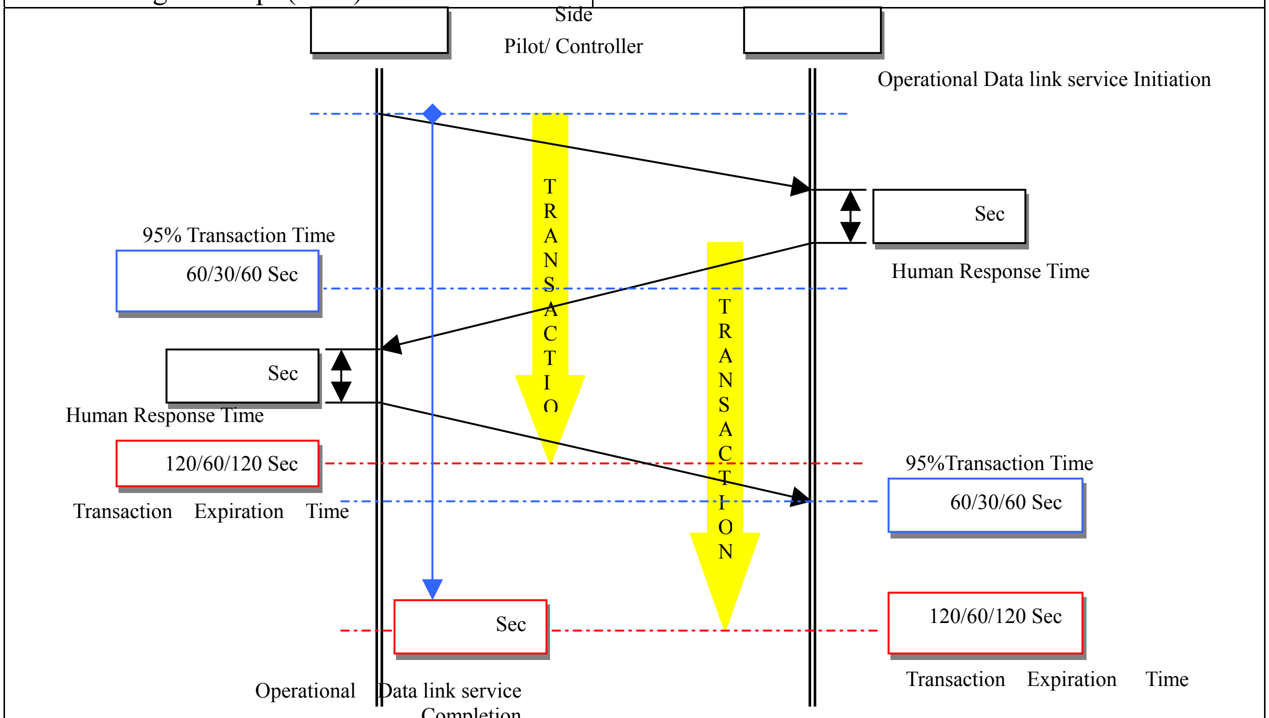
The ACL Service may be used in either of the following situations:

- When the execution of the instruction is not time critical based on aircrew and controller judgement;
- As a back up to voice communications.

The ACL Service will not be used in either of the following situations:

- Emergency situation;
- Safety related communications, where time is the dominant factor.

Pilot:	ATC:
the request for the clearance	
	the delivery of the clearance
Acknowledges receipt (Note)	



Note; ‘Acknowledges receipt’ by pilot is not explicitly stated, but it is added here for the consistency.

ACL	Parameter	Environment	RCP Values
	TT_{95}	En-Route	60 sec
	ET_{RCP}	En-Route	120 sec
	TT_{95}	TMA/TRACON	30 sec
	ET_{RCP}	TMA/TRACON	60 sec
	TT_{95}	Surface	60 sec.
	ET_{RCP}	Surface	120 sec

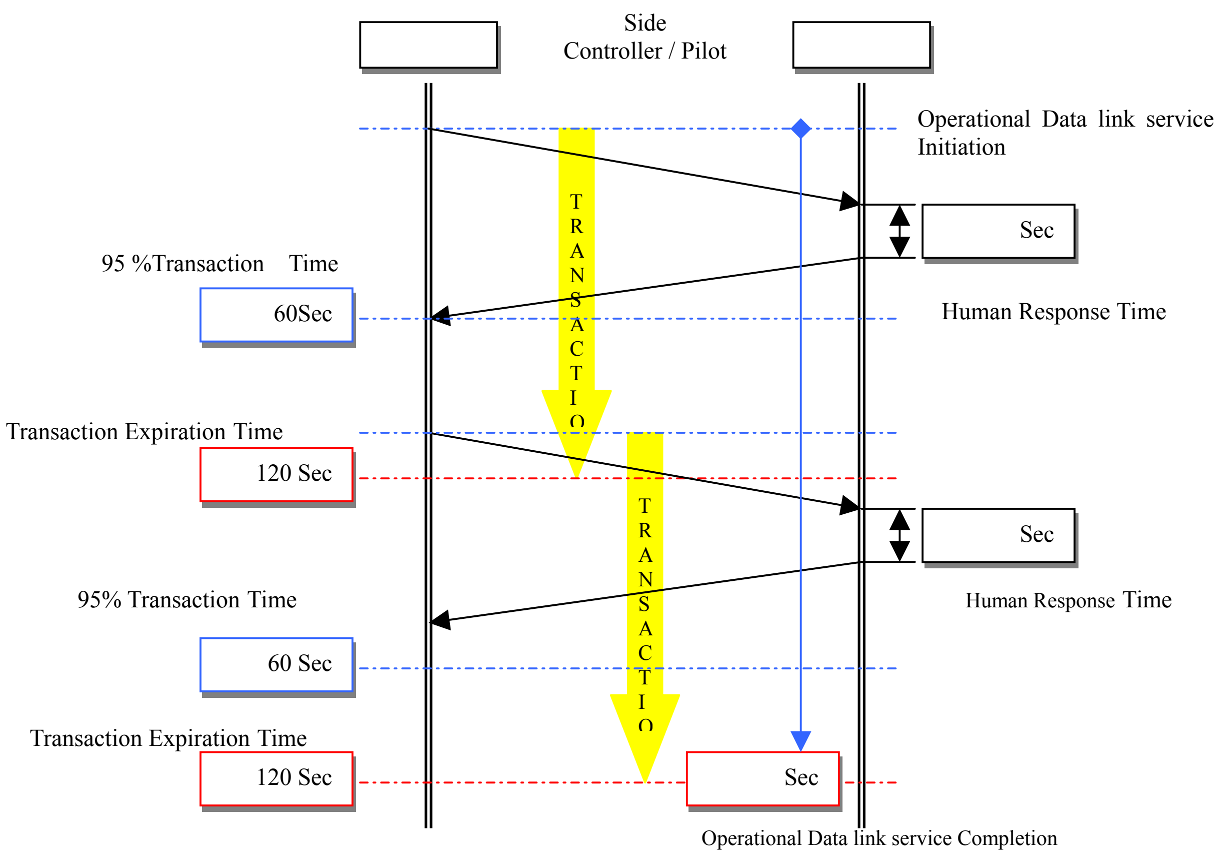
3) ACM service

When a flight is about to be transferred from one sector/ATSU to another sector/ATSU, the aircrew is instructed to change to the voice channel of the next sector/ATSU The ACM Service provides automated assistance to the aircrew and current and next controllers for conducting this transfer of ATC communications. The ACM Service encompasses the transfer of voice and data communications.

> NOTE :Transfer of communications within one ATSU (i.e. transfer from one sector to another, within the same ATSU) is out of the scope of this document.

This approach provides a transparent transfer of data communications, in synchronization with the transfer of voice communications. It also retains the operational principle that there is only one controlling authority, and that the controlling authority is properly and unambiguously determined.

ATC:	Pilot:
(current)instruct for the change	
	the delivery of the clearance
(next) contact	
	response



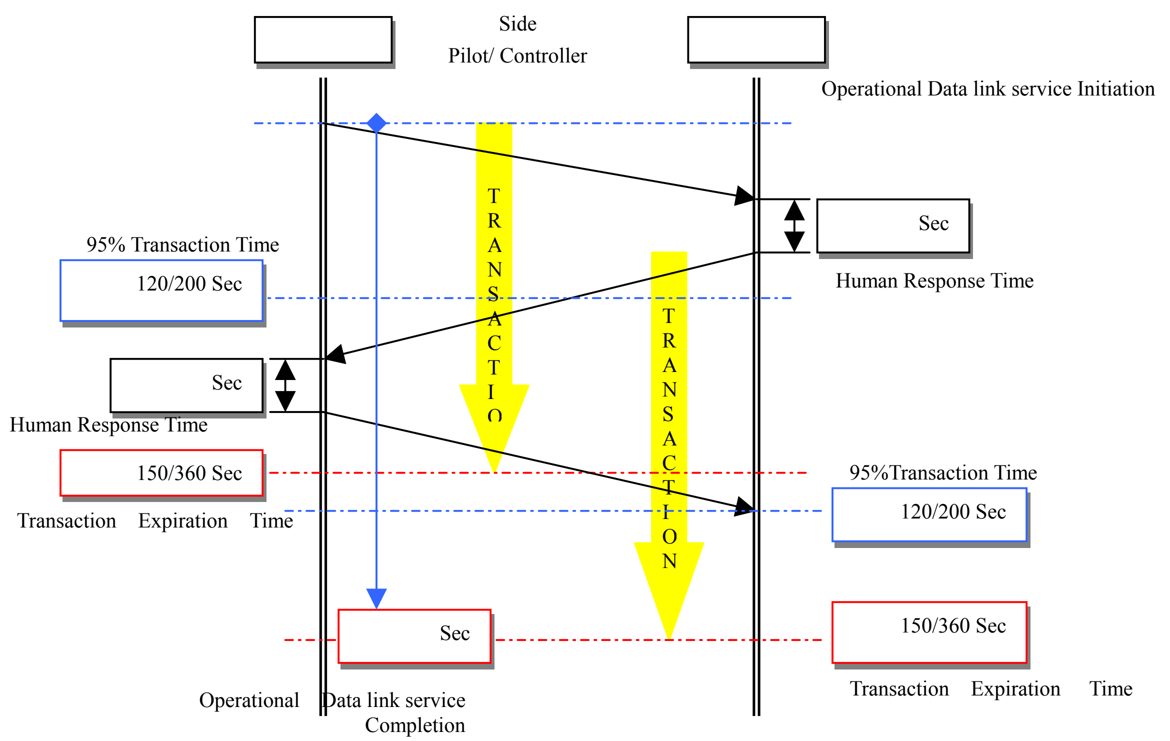
Note; The current and next ATSU exchange information using ground-ground communication.

ACM	Parameter	Environment	RCP Values
	TT_{95}	En-Route	60 sec
	ET_{RCP}	En-Route	120 sec

4) DCL service

An aircraft under control of an ATSU transmits requests for departure. The DCL service describes the dialogue procedures to be followed to perform the request and the delivery of the departure clearance via air-ground data communications. The ACL service is used on the surface.

Pilot:	ATC:
the request for the departure clearance	
	the delivery of the departure clearance
Acknowledges receipt (Note)	



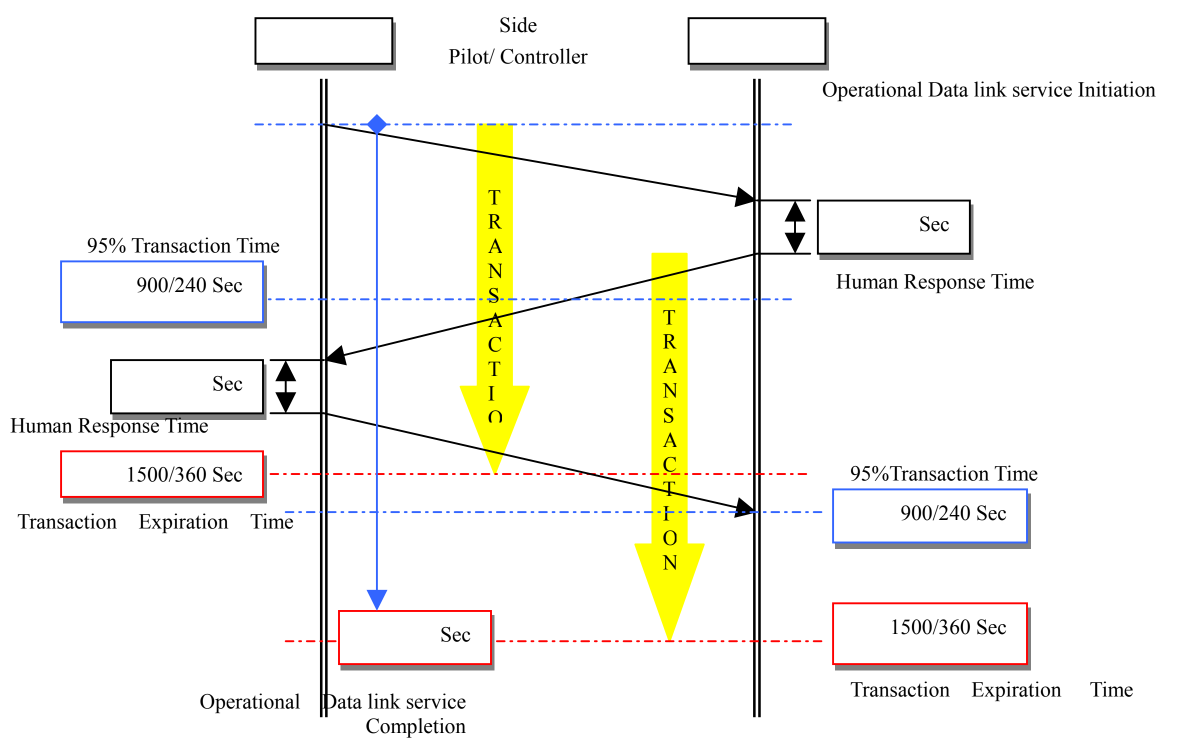
Note; 'Acknowledges receipt' by pilot is not explicitly stated, but it is added here for the consistency.

DCL	Parameter	Environment	RCP Values
	TT_{95}	Departure Request	120 sec
	ET_{RCP}	Departure Request	150 sec
	TT_{95}	Operational Reply	200 sec
	ET_{RCP}	Operational Reply	360 sec

5) DSC service

The DSC service describes the dialogue procedures to be followed to perform the request for and the delivery of an oceanic clearance via air-ground data communications. The use of DSC service for advance arrival information is out of scope of this document.

Pilot:	ATC:
the request for an oceanic clearance	
	the delivery of an oceanic clearance
Acknowledges receipt (Note)	



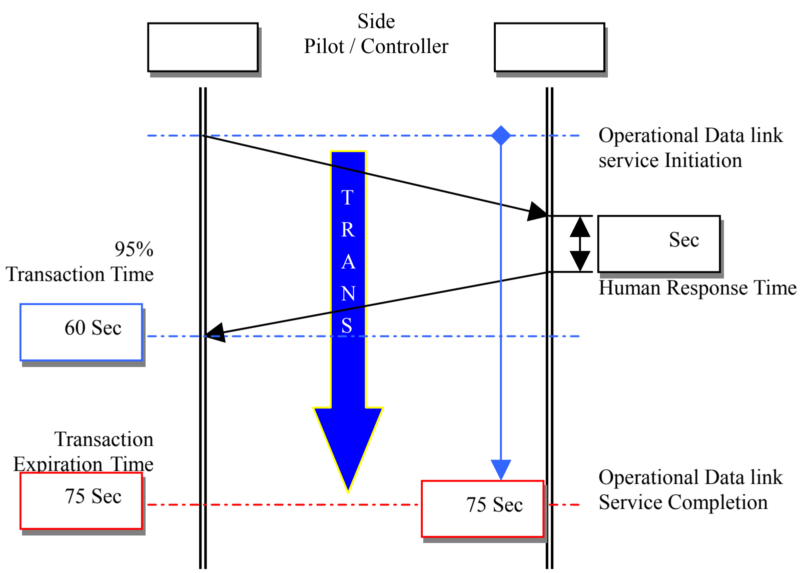
Note; 'Acknowledges receipt' by pilot is not explicitly stated, but it is added here for the consistency.

DSC	Parameter	Environment	RCP Values
	TT_{95}	Request	900 sec
	ET_{RCP}	Request	1500 sec
	TT_{95}	Operational Reply	240 sec
	ET_{RCP}	Operational Reply	360 sec

6) D-ATIS service

An aircraft under the control of an ATSU transmits request for air traffic information, such as weather. The D-ATIS service describes the dialogue procedures to be followed to perform these exchanges via air-ground data communications. The D-ATIS service is used on the surface and in the TMA environment.

D-ATIS service	
Pilot:	ATC:
request for air traffic information	
	transmits air traffic information



D-ATIS	Parameter	Environment	RCP Values
	TT_{95}	Request	60 sec
	ET_{RCP}	Request	75 sec

2.1.2 Operational Performance Requirements; RCP values

(1) Time/Timing

ACL	Parameter	Environment	RCP Values
	TT_{95}	En-Route	60 sec
	ET_{RCP}	En-Route	120 sec
	TT_{95}	TMA/TRACON	30 sec
	ET_{RCP}	TMA/TRACON	60 sec
	TT_{95}	Surface	60 sec
	ET_{RCP}	Surface	120 sec

- En-route

The one-way transit delay shall be maximum 6.5 sec.
This means that the 95% pilot or controller response time shall be less than =47 sec. (60-2x6.5)

- TMA/TRACON

The one-way transit delay shall be less than 6.5 sec. This means that the 95% pilot or controller response time shall be less than 17 sec. (30-2x6.5) Given the fact that in a TMA/TRACON environment the pilot is very attentative to instructions or clearances and is in general not down linking requests, this is an achievable value.

- Surface

Taxi clearance is an application of ACL for surface area operations. As the aircraft is not yet airborne and checklist activities are performed, the time can be analogous to the en-route operations. The one-way transit delay shall be no more than 6.5 sec. This means that the 95% pilot or controller response time shall be less than 60-2x6.5=47 sec.

ACM	Parameter	Environment	RCP Values
	TT_{95}	En-Route	60 sec
	ET_{RCP}	En-Route	120 sec

The one-way transit delay shall be less than 6.5 sec.
This means that the 95% pilot or controller response time shall be less than 47 sec. (60-2x6.5)

DCL	Parameter	Environment	RCP Values
	TT_{95}	Departure Request	120 sec
	ET_{RCP}	Departure Request	150 sec
	TT_{95}	Operational Reply	200 sec
	ET_{RCP}	Operational Reply	360 sec

- Departure Request

This is the time, the pilot sends a departure request through the time that the controller reviews and accepts the request and transmits a response to the pilot.

The one-way transit delay shall be less than 11 sec. (see chapter 5 for details)
This means that the 95% controller response time shall be less than 120-2x11=98 sec.

- Operational Reply

This is the time, the controller sends the departure clearance through the time that the pilot reviews and accepts the clearance and transmits a response to the controller.

The one-way transit delay shall meet maximum 11 sec. (see chapter 5 for details)

This means that the 95% pilot response time shall be less than 178 sec (200-2x11).

DSC	Parameter	Environment	RCP Values
	TT_{95}	Request	900 sec
	ET_{RCP}	Request	1500 sec
	TT_{95}	Operational Reply	240 sec
	ET_{RCP}	Operational Reply	360 sec

- Request

This is the time, the pilot sends a clearance request through the time that the controller reviews and accepts the request and transmits a response to the pilot.
The one-way transit delay shall be less than 90 sec. (see chapter 5 for details)
This means that the 95% controller response time shall be less than 720 sec. (900-2x90)

- Operational Reply

This is the time, the controller sends the departure clearance through the time that the pilot reviews and accepts the clearance and transmits a response to the controller.
The one-way transit delay shall be less than 90 sec. (see chapter 5 for details)
This means that the 95% pilot response time shall be less than 60 sec. (240-2x90)

D-ATIS	Parameter	Environment	RCP Values
	TT_{95}	Request	60 sec
	ET_{RCP}	Request	75 sec

- Request

This is the time, the pilot sends a request through the time that the controller reviews and accepts the request and transmits a response to the pilot.

D-ATIS is required in the terminal environment and therefore the response needs to be fast.

Note: D-ATIS does not need the involvement of the controller as the response is generated by the ground system.

(2) Other Parameter Values

	A_{RCP}	$A_{Provision}$	C_{RCP}
ACL	> 0.999	≥ 0.9999	≥ 0.995
ACM	> 0.999	≥ 0.9998	≥ 0.995
DCL	> 0.993	≥ 0.994	≥ 0.99
DSC	> 0.993	≥ 0.994	≥ 0.999
D-ATIS	> 0.993	≥ 0.994	≥ 0.99

2.2 Communication Services; DO-274

2.2.1 Communication Service Description in DO-274

1. Communications Management Services
Communications Management Services are defined to manage access to the communications system and alleviate pilot and controller workload by reducing repetitive and routine tasks. Specific services defined by other RTCA committees and that are considered to be included in this service are Datalink Initiation Capability (DLIC), ATC Microphone Check (AMC), ATC Communications Management (ACM) Service, Authentication Ser-vice, and Transfer of Communications (TOC) Service. To illustrate the use of the Communications Management Service, scenarios for the following occurrences have been developed and are provided below: • Transfer of Communications • Failure Recovery • Stuck Microphone • Ground Radio Failure • Aircraft Radio Failure • Controller Override
2. Planning Communications Service
The Planning Communications Service supports communications accomplished for planning purposes which do not require any urgency in time. This type of communications service will be accomplished primarily through data link communications for equipped aircraft. To illustrate the use of the Planning Communications Service, scenarios for the following occurrences have been developed and are provided below: • File flight plan • Initial clearance delivery • Initial clearance delivery after a short delay
3 Strategic Communications Service
This communications service is expected to support communications for strategic decisions or actions. In other words, these are communications accomplished which have an intermediate amount of time between the communications transaction and any actions taken as a result of information gained through that transaction. This type of communications service will be highly collaborative and lends itself well to data link, and it is expected that where possible, many or most of these transactions will be accomplished via data link. It is expected that the type of information transmitted with strategic communications services will be the most varied of any of the communications types. Use of data link communications is expected to increase (assuming that the data link service has been certified, and the strategic communications service requirements are met) and may consist of graph-ical and/or textual depictions of flight plans, flight data, and weather. For aircraft not equipped with data link capabilities that support strategic communications service, voice communications that support strategic (or more stringent service requirements) may be used. It should be noted that in order for this to be successful with data link, it is vitally important that there be a high degree of automation in the Human Machine Interface (HMI) for both the pilot and controller. It is also necessary that all stakeholders in the transaction have a common picture of the airspace (possibly in a graphical form) from which to base their collaboration. This picture could include information such as weather, turbulence, and airspace restrictions in a form that is easily interpreted. Ideally, the aircraft's intended route of flight as well as its suggested route of flight will be portrayed. With this common situational awareness, a collaborative decision can be reached in minimum time with no confusion. To illustrate the use of the Strategic Communications Service, scenarios for the following flight situations have been developed and are provided below: • Pilot requests direct to a fix • Pilot requests change of altitude due to continuous light turbulence • Pilot requests a routing change to avoid weather that is <150 NM> ahead on his current cleared route

4. Tactical Communications Service
This communications service supports tactical decisions or actions. In other words, communications are accomplished which have a short amount of time between the communications transaction and any actions that need to be taken as a result of information gained through that transaction. Proper design of the future NAS architecture and procedures with effective collaborative decision making enabled by a robust strategic communications service will decrease the need for tactical communications services. No matter how well the stakeholders accomplish strategic decision making, however, there will always be a need for tactical communications. The decision to use voice or data link for tactical communications, as always, rests with the user and is situation dependent. The user will only choose to use data link communications in lieu of voice if he feels it is just as safe, has a transaction time that is as quick as voice, and most of all, is easier to accomplish than voice. With this in mind, the data link system must have low latency, superior automation and integration, and excellent HMI. To illustrate the use of the Tactical Communications Service, the following scenarios have been developed and are provided below: • Pilot request for tactical maneuver denied by ATC • Request for clearance with immediate approval • Request for clearance approved after slight delay • ATC delivers taxi clearance
5. Emergency Communications Service
This communications service is defined by communications transactions that cannot tolerate any delay. Information must be conveyed immediately with no confusion. In most cases the communications will be advisory in nature in that the communications will occur after the action has commenced. However, not all communications accomplished during an emergency will fall into the emergency communications service category. If there is time to wait before an action is accomplished then that communications may fall into the tactical or strategic category. For example, a pilot coordinating for emergency equipment for an arrival at a destination in 30 minutes would be considered strategic communications.. Because of the unusual nature of In Flight Emergencies and the communications transactions that accompany them, data link will only see limited use. Most of these types of transactions will be accomplished by voice. Data link communications could be even more beneficial in some recurring cases if the messages were predefined and automated, and any human factor issues were resolved. As an example, a message could be armed for takeoff that will automatically inform the tower of a Rejected Takeoff (RTO) when certain parameters are met after brake release on take-off roll. There are numerous messages that could be pre-programmed and delivered automatically or cued for the user to send with minimal effort. This would ensure timely delivery as well as decrease pilot workload during a critical time. To illustrate the use of the Emergency Communications Service, the following scenarios have been developed and are provided below: • Pilot advising ATC of a TCAS resolution advisory • Aircraft experiences engine failure after takeoff while under departure control • Emergency descent

2.2.2 Rating of Operational Timing Performance in DO-274

The following tables are provided the rating of operational timing performance for the communication services described in DO-274.The tables show the relative ratings rather than specific values of the RCP parameters.

Table Attributes Derived from DO-264 (Appendix F) and Adapted for SC-198 [6]

Communications Service	Attribute	Definition Levels of Service *Note: 1 represents most stringent service level*
Time Constraint • Transaction Expiration Time (ET_{RCP}) • 95% Transaction Time (TT_{95})	Maximum time for completion of transaction(or transmission) after which peer par-ties should revert to an alternate procedure Time before which 95% of the transactions need to be completed	1 – Immediate 2 – Very Short 3 – Short 4 – Long, Intermediate 5 – Very Long
Priority/Preemption/Precedence	Ability of specific communications messages or transactions to be put ahead of (priority) or interrupt (preemption) other messages or transactions.	1 – Required 2 – Highly Desired 3 – Desired 4 (not used) 5 – Not Needed
Integrity (Accuracy)	Probability that the transaction (or transmission) is completed without error	1 – Very High 2 – High 3 – Intermediate 4 – Low 5 – Very Low
Continuity	Probability that the transaction will be completed before the transaction's expiration time, assuming that the communications system is available when the transaction is initiated.	1 – Very High 2 – High 3 – Intermediate 4 – Low 5 – Very Low
Availability	Probability that communications system between two parties is in service	1 – Very High 2 – High 3 – Intermediate 4 – Low 5 – Very Low
Addressability	Only the specific target entity(s) receives the communications. (No party-line and not broadcast unless selected to be so.)	1 – Required 2 – Highly Desired 3 – Desired 4 (not used) 5 – Not Needed
Frequency of Occurrence (Anticipated Communications Traffic Volume)	Qualitative measure of how often this type of communication will occur in the future NAS Note: could define this as approximate number of transactions per period of time.	1 – Very Often 2 – Often 3 (not used) 4 – Seldom 5 – Almost Never

Table Summary of Service Attributes[6]

ATTRI BUTE NEXCOM SERVICE	Timing		Priority/ Preemption/ Precedence	Integrity	Continuity	Availability	Address-ability	Frequency of Occurrence
	Transaction (TT 95)	Expiration (ET RCP)						
Communications Management Services	2 (Very Short)	2 (Very Short)	2 (Highly Desired)	1 (Very High)	1 (Very High)	1 (Very High)	1 (Required)	1 (very often) 10 per flight
Planning Communications Services	5 (Very Long)	5 (Very Long)	5 (Not Needed)	1 (Very High	3 (Intermediate)	3 (Intermediate)	2 (Highly Desired)	2 (often) 2- 3 per flight
Strategic Communications Services	3 (Intermediate)	3 (Intermediate)	5 (Not Required)	1 (Very High)	2 (High)	2 (High)	2 (Highly Desired)	1 (very often) 5- 7 per flight
Tactical Communications Services	2 (Very Short)	2 (Very Short)	2 (Highly Desired)	1 (Very High)	1 (Very High)	1 (Very High)	2 (Highly Desired)	2 (often) 3- 5 per flight
Emergency Communications Services	1 (Immediate)	1 (Immediate)	2 (Highly Desired) Note	1 (Very High)	1 (Very High)	1 (Very High)	2 (Highly Desired)	5 (almost never) < 1 per flight

Note: Service Attribute, Priority/ Preemption/ Precedence for Emergency Communications Service was considered "Highly Desired" as opposed to "Required" because of the extremely low frequency of occurrence, and the assumed continued provisioning of 121.5 MHz for Emergency Communications. (Section 3.5.3)

2.2.3 Proposed RCP parameter values of attributes in DO-274

It is worth while to give reasonable specific values for each timing performance rating in DO-274.
After consulting to an expert of ATC (ex-controller), the following parameter values are proposed as the first cut for further discussions.

	1 (Immediate)	2 (Very Short)	3 (Intermediate)	4 (Long)	5 (Very Long)
Transaction (TT 95)	3	10	30	60	120
Expiration (ET RCP)	5	20	60	120	240

Note;
1) Depending on the air space, the RCP values for the same communication service may differ in case of clearance, because of the ability or inability to maneuver. In some cases, RCP values in En-route are proposed as three times larger as in TMA, and some larger values for Surface.
2) It is considered that 5 min (300 sec) is the upper limit of any elapsed time for the communication services.
3) The values in case of ‘immediate’ and ‘very short’ may be the subject to be discussed, for instance, TT95 = 5 sec instead of 3 sec, TT95 = 15 sec instead of 10 sec.

Note; The editor of the document acknowledges the help provided by Mr. Koichi KIMURA.

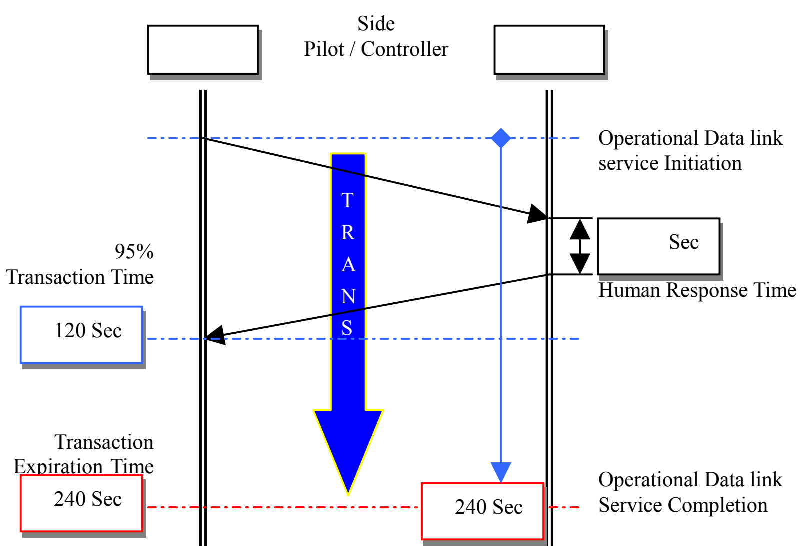
2.2.4 Detail Communication Scenarios based on DO-274

In the following, the RCP timing values are associated with each communication scenario in DO-274.

<table>
<tr><th colspan="3">1. Communications Management Services</th></tr>
<tr><td colspan="3">Scenario 1.1: Transfer of Communications</td></tr>
<tr><td rowspan="3"></td><td colspan="2">Provides automatic circuit management to reduce controller and pilot workload and to reduce potential for frequency tuning errors. Allows seamless transition of voice and/or data communications between pilots and controllers. The following is an example of a controller to controller handoff under NEXCOM.
Controller Perspective:
• Controller executes handoff procedure
• Transfer of communications for aircraft is initiated and executed
• Next controller has indication that aircraft is tuned to the sector channel (HF)
• Communications capabilities are provided (i.e., voice, voice and data) (HF)
Pilot Perspective:
• Pilot provided indication of communications connections
• Transfer of communications acknowledged by Pilot (HF)
• Tuning capabilities are provided for pilot. (HF)</td></tr>
<tr><td>Pilot:</td><td>ATC:</td></tr>
<tr><td colspan="2">Note; Since some of the communications are in voice, we omit the detailed description in the scenario. The same description appears in ACM in section 2.1.</td></tr>
</table>

<table>
<tr><td colspan="3">Scenario 1.2a: Failure Recovery — Stuck Microphone</td></tr>
<tr><td rowspan="3"></td><td colspan="2">Pilot’s microphone gets stuck
• Controller notices stuck mic by means of stuck mic indicator, and
• Controller clears, or
• Controller broadcasts “stuck mic” notification to all users, users check their mic, and user with stuck mic clears, OR
• Pilot notices stuck mic by means of stuck mic indicator and clears, OR
• Ground system automatically clears stuck mic after time <tbd>, OR
• Local airborne system automatically clears stuck mic after time <tbd>
Controller’s mic gets stuck (HF)
• Controller notices stuck mic by means of stuck mic indicator and clears, OR
• Pilots notice and make use of available capabilities to notify air traffic control</td></tr>
<tr><td>Pilot:</td><td>ATC:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="3">Scenario 1.2b: Failure Recovery — Loss of communications due to ground radio failure</td></tr>
<tr><td rowspan="3"></td><td colspan="2">Provides failure detection and recovery capabilities, allowing the communications system to identify and recover from communications system failures, and supports meeting service availability requirements. In this scenario, controller workload may be reduced, and system availability may be increased if system can recover from ground radio failure.
Controller Perspective:
• Indication of radio failure given to controller
• Controller manually switches to backup resource
Pilot Perspective:
• Transparent</td></tr>
<tr><td>Pilot:</td><td>ATC:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="3">Scenario 1.2c: Failure Recovery — Total loss of airborne VHF radio capability</td></tr>
<tr><td rowspan="3"></td><td colspan="2">In this scenario, notification of communications failure is provided to both the affected pilot and controller.
Pilot Perspective:
• Indication of VHF radio system failure given to pilot (HF) (Fallback to communications failure contingency procedures)
Controller Perspective:
• Indication of loss of voice communications to controller for specific aircraft (HF) (Fallback to communications failure contingency procedures)</td></tr>
<tr><td>Pilot:</td><td>ATC:</td></tr>
<tr><td></td><td></td></tr>
</table>

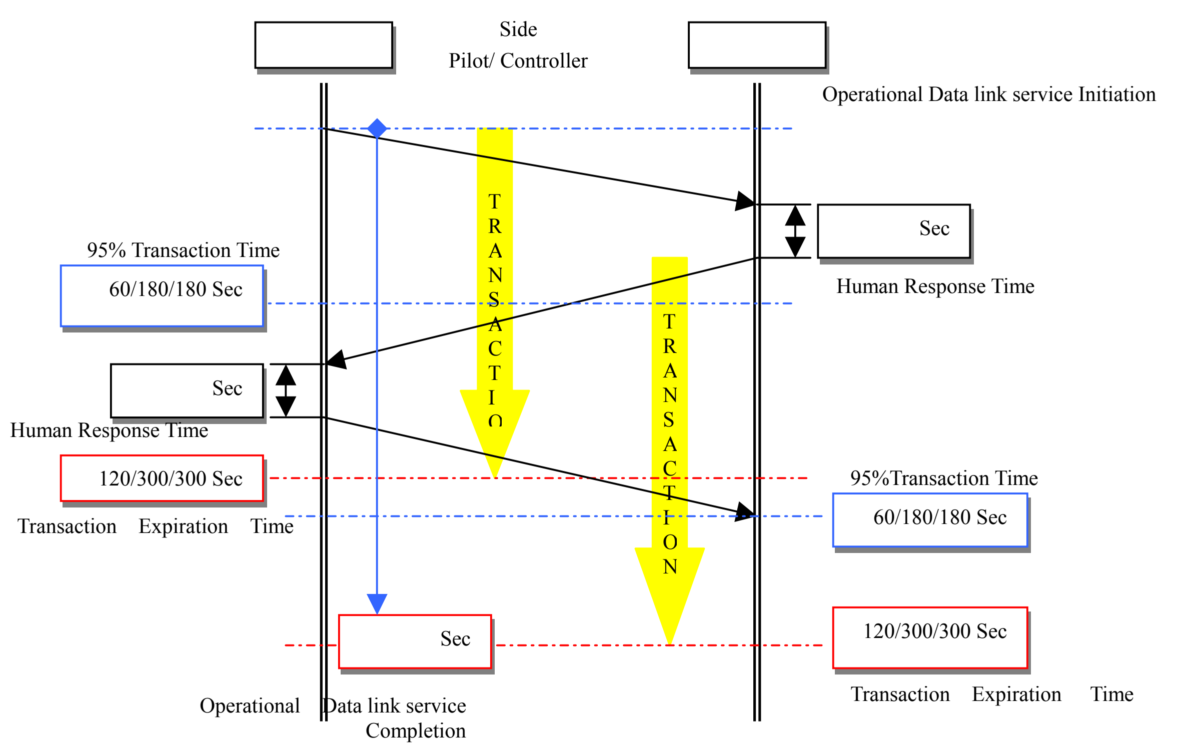
Scenario 1.3: Controller Override		
	Provides a controller, the ability to preempt other communications on the voice channel. Controller Perspective: • Controller has aircraft in position, ready for immediate take off, waiting for clearance, with a short window of opportunity (another aircraft coming in to land on the same runway) • Just as controller is ready to issue clearance, another aircraft checks in and occupies the channel, making a relatively long request *(HF)* • Controller overrides, and issues take-off clearance to waiting aircraft Pilot Perspective: • All pilots are aware that the controller exercised controller override *(HF)*	
	Pilot:	ATC:
2. Planning Communications Service		
Scenario 2.1: File flight plan		
	Pilot:	ATC:
	transmits flight plan	
		acknowledges receipt



Services	Transaction (TT 95)	Expiration (ET RCP)
Planning Communications Services	5 (Very Long)	5 (Very Long)
Proposed RCP values	120	240

Scenario 2.2: Initial clearance delivery

Pilot:	ATC:
Requests flight plan clearance	
	Transmits clearance
Acknowledges receipt	

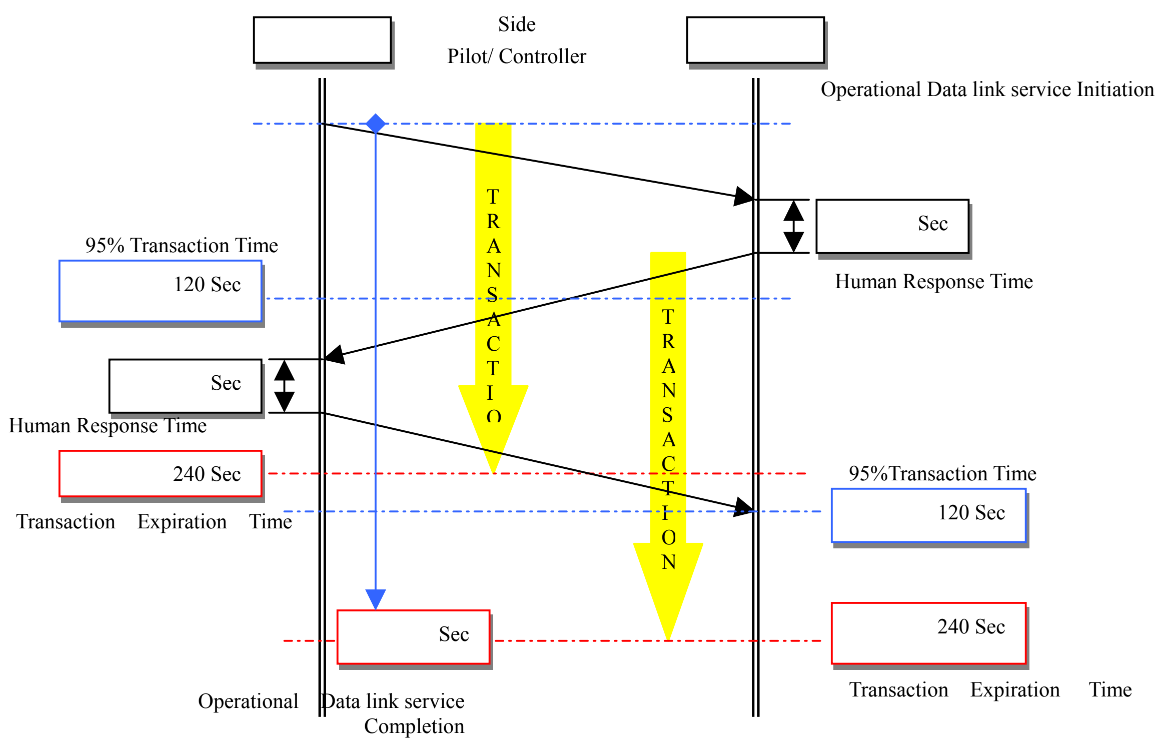


DO-274		
Services	Transaction (TT 95)	Expiration (ET RCP)
Planning Communications Services	5 (Very Long)	5 (Very Long)
TMA	60	120
Enroute	180(3 x TMA)	300(5 min)
Surface	180(3 min)	300(5 min)

Note Although ‘Very Long’ means 120sec, we adopt here 60 sec for TMA(see section 2.1) and 180 sec (three times of TMA).

Scenario 2.3: Initial clearance delivery after short delay

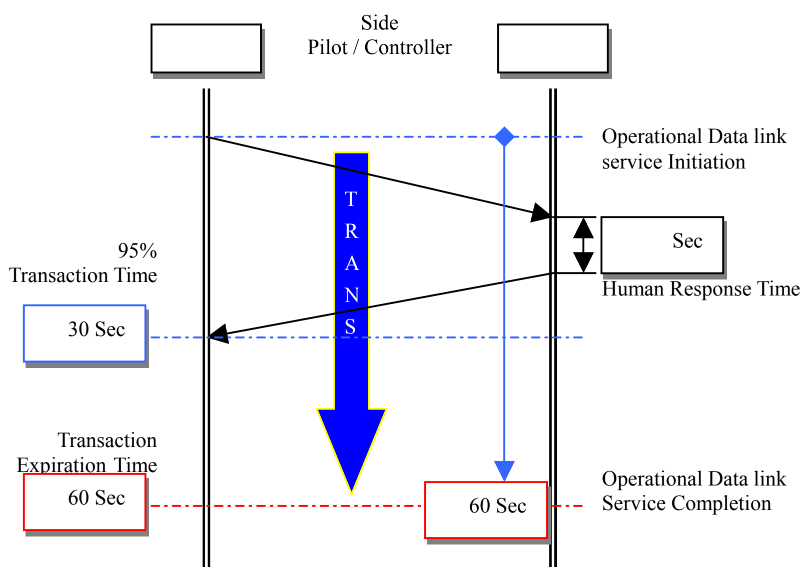
Pilot:	ATC:
Requests flight plan clearance	
	Transmits “standby”
	Transmits clearance
Acknowledges receipt	



Services	Transaction (TT 95)	Expiration (ET RCP)
Planning Communications Services	5 (Very Long)	5 (Very Long)
Proposed RCP Values	120	240

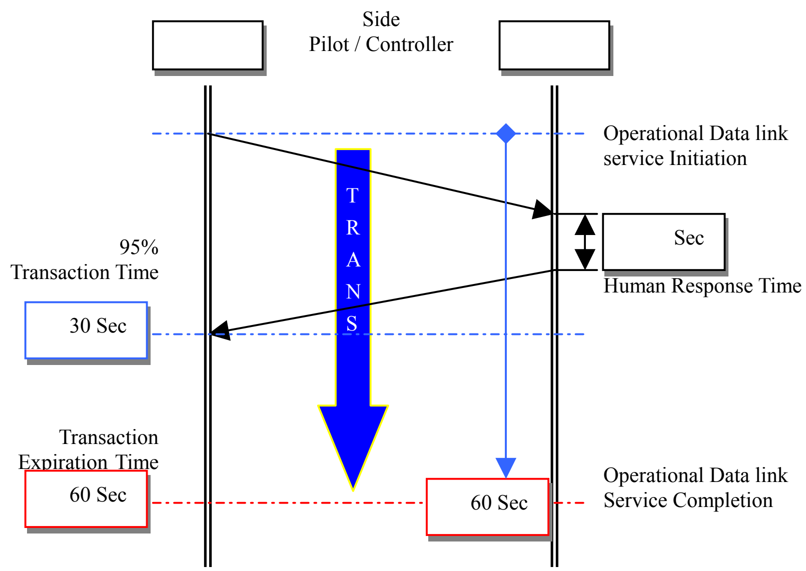
Note; The RCP value shows the response performance of ‘standby’, not the delayed clearance.

3 Strategic Communications Service		
Scenario 3.1: Pilot requests direct to a fix		
	1a) Aircraft is flying on a flight plan that takes it from points A to B to C around a military SUA. The aircraft is at point A.	
	Pilot:	ATC:
	Requests direct point C	
		Negative (SUA currently active)



Services	Transaction (TT 95)	Expiration (ET RCP)
Strategic Communications Services	3 (Intermediate)	3 (Intermediate)
Proposed RCP Values	30	60

1b) Aircraft over fix requests vector to another fix	
Pilot:	**ATC:**
Requests a vector to another fix	
	Clearance with assigned heading until aircraft is able to navigate to next fix

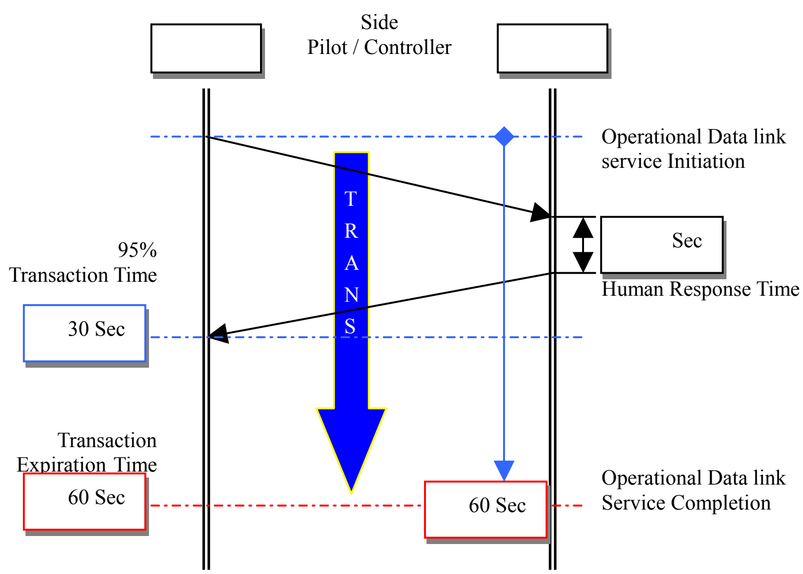


Services	Transaction (TT 95)	Expiration (ET RCP)
Strategic Communications Services	3 (Intermediate)	3 (Intermediate)
Proposed RCP Values	30	60

Scenario 3.2: Pilot requests change of altitude due to continuous light turbulence

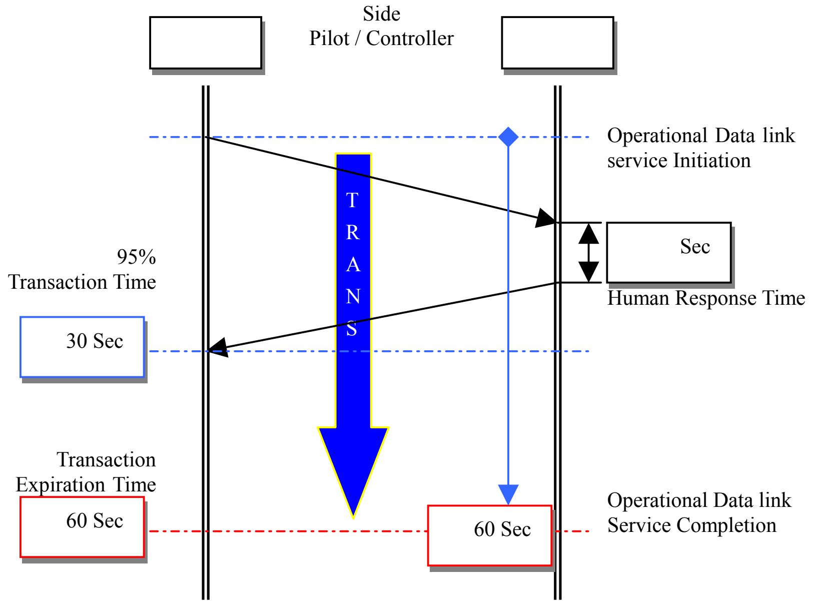
2a) Aircraft encounters turbulence at assigned altitude. Through FIS, pilot knows that little or no turbulence will be encountered at a higher altitude.

Pilot:	ATC:
Requests climb to a higher, specific altitude due to turbulence	
	Clears aircraft to climb and maintain new assigned altitude



Services	Transaction (TT 95)	Expiration (ET RCP)
Strategic Communications Services	3 (Intermediate)	3 (Intermediate)
Proposed RCP Values	30	60

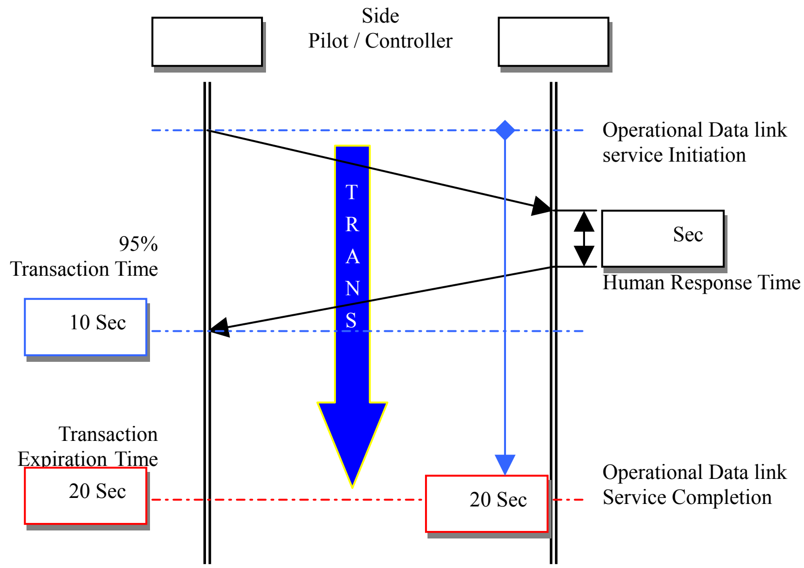
	2b) Aircraft is flying at assigned altitude and encounters continuous light turbulence.	
	Pilot:	**ATC:**
	Request climb to a higher, specific altitude due to turbulence	
		Due to close proximity to next facility/sector, directs pilot to contact the next facility/sector and make request with that facility/sector



Services	Transaction (TT 95)	Expiration (ET RCP)
Strategic Communications Services	3 (Intermediate)	3 (Intermediate)
Proposed RCP Values	30	60

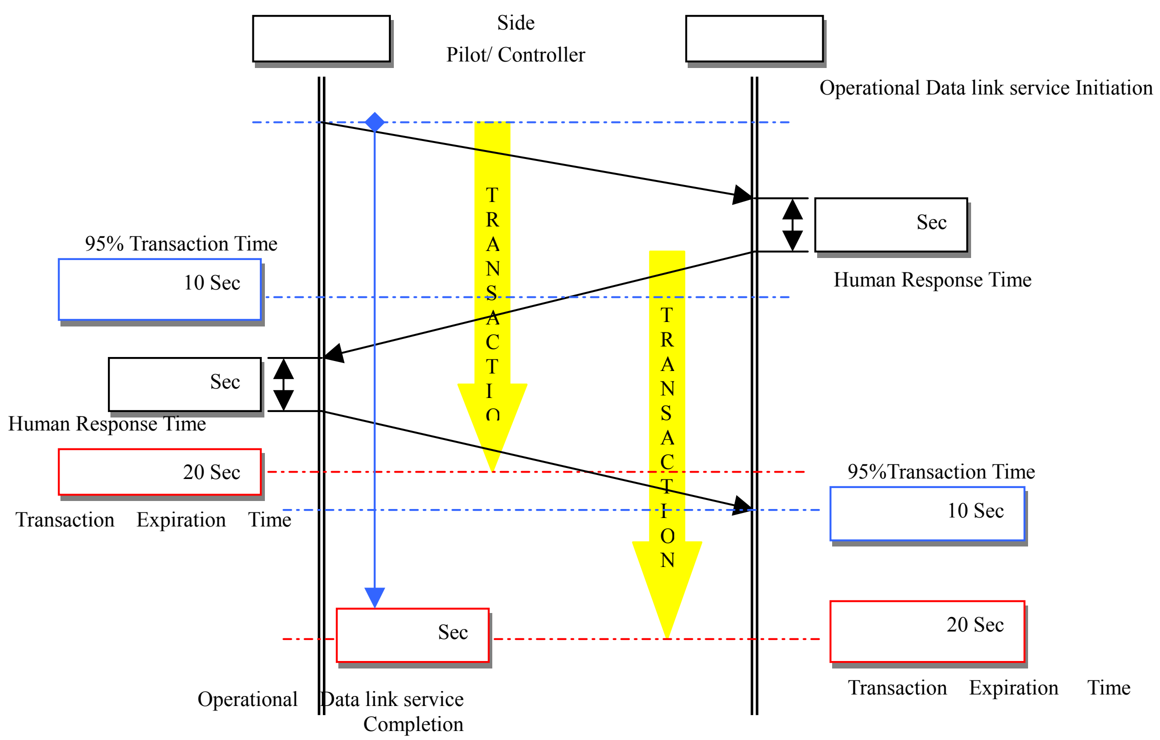
Scenario3. 3: Pilot requests a routing change to avoid weather that is <150 NM> ahead on his current cleared route		
	Pilot:	**ATC:**
	Through future FIS the pilot learns that a thunderstorm has developed 150 NM ahead on his route of flight.	
	requests a routing change to avoid weather that is <150 NM> ahead on his current cleared route	

4. Tactical Communications Service		
Scenario 4.1: Pilot request for tactical maneuver denied by ATC		
	Aircraft is in terminal area and the pilot has airport in sight. Pilot has been cleared for the visual approach to Runway 24L. Pilot requests to sidestep to Runway 24R. ATC denies the request due to departing traffic.	
	Pilot:	**ATC:**
	Requests Sidestep for Visual Approach to Runway 24R	
		Transmits Unable (Departing Traffic)



Services	Transaction (TT 95)	Expiration (ET RCP)
Tactical Communications Services	2 (Very Short)	2 (Very Short)
Proposed RCP Values	10	20

Scenario 4.2: Request for clearance with immediate approval		
	Aircraft is in cruise flight in instrument meteorological conditions (IMC). The pilot observes a large thunderstorm building in his flight path.	
	Pilot:	ATC:
	Requests specific deviation from assigned heading or route	
		Clears aircraft to deviate by the specific amount and then resume on course
	Acknowledges receipt	

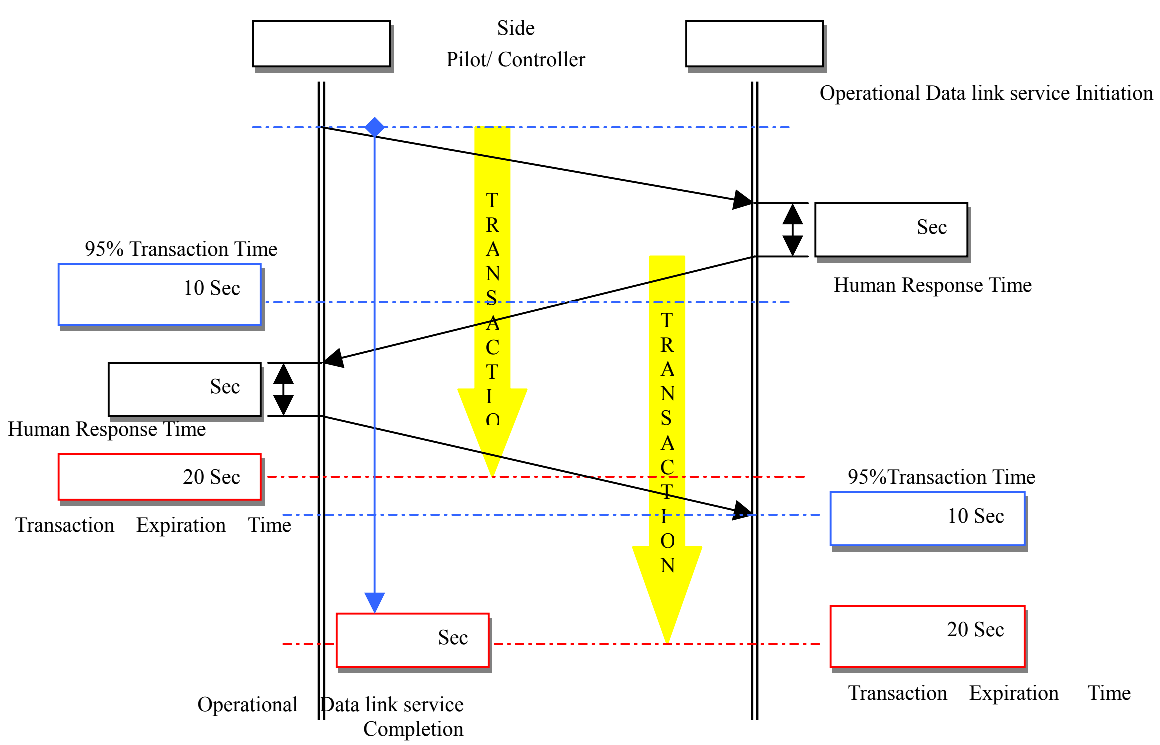


Services	Transaction (TT 95)	Expiration (ET RCP)
Tactical Communications Services	2 (Very Short)	2 (Very Short)
Proposed RCP Values	10	20

Scenario4.3: Request for clearance approved after slight delay

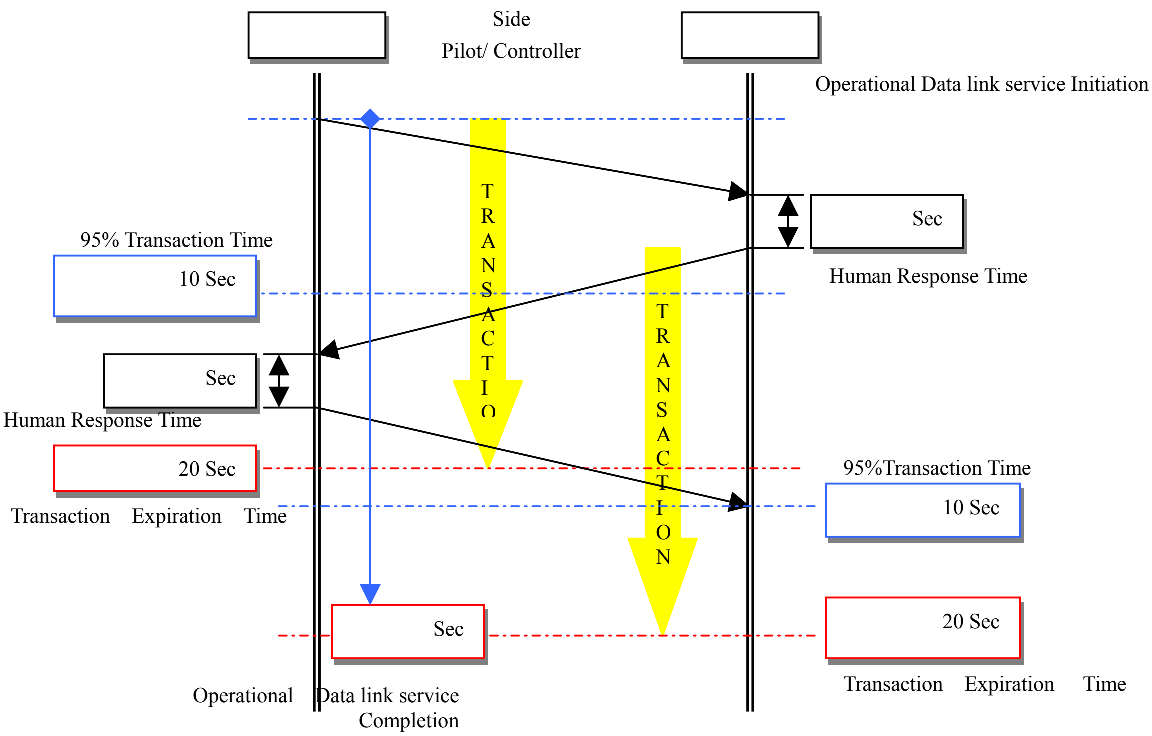
Aircraft is in terminal area and wants a lower altitude to help with approach energy management (e.g., to help aircraft acquire the glide slope with proper airspeed.)

Pilot:	ATC:
Requests lower altitude	
	Expect lower altitude when clear of traffic
	Clears aircraft to descend to requested lower altitude
Acknowledges receipt	



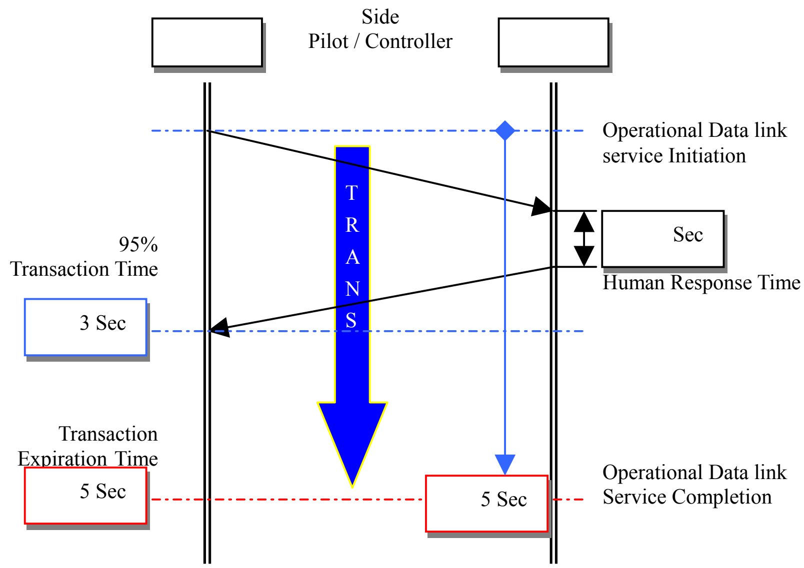
Services	Transaction (TT 95)	Expiration (ET RCP)
Tactical Communications Services	2 (Very Short)	2 (Very Short)
Proposed RCP Values(sec)	10	20

Scenario 4.4: ATC delivers taxi clearance		
	Aircraft in non-movement area of airport requests taxi clearance.	
	Pilot:	ATC:
	Requests taxi clearance	
		Clears aircraft to taxi to designated runway
	Acknowledges receipt	



Services	Transaction (TT 95)	Expiration (ET RCP)
Tactical Communications Services	2 (Very Short)	2 (Very Short)
Proposed RCP Values(sec)	10	20

5. Emergency Communications Service	
Scenario 5.1: Pilot advising ATC of a TCAS Resolution Advisory	
Aircraft is flying level in the terminal area and receives a TCAS Resolution Advisory to Climb.	
Pilot:	ATC:
Informs ATC of maneuver for a TCAS resolution advisory	
	Acknowledges receipt

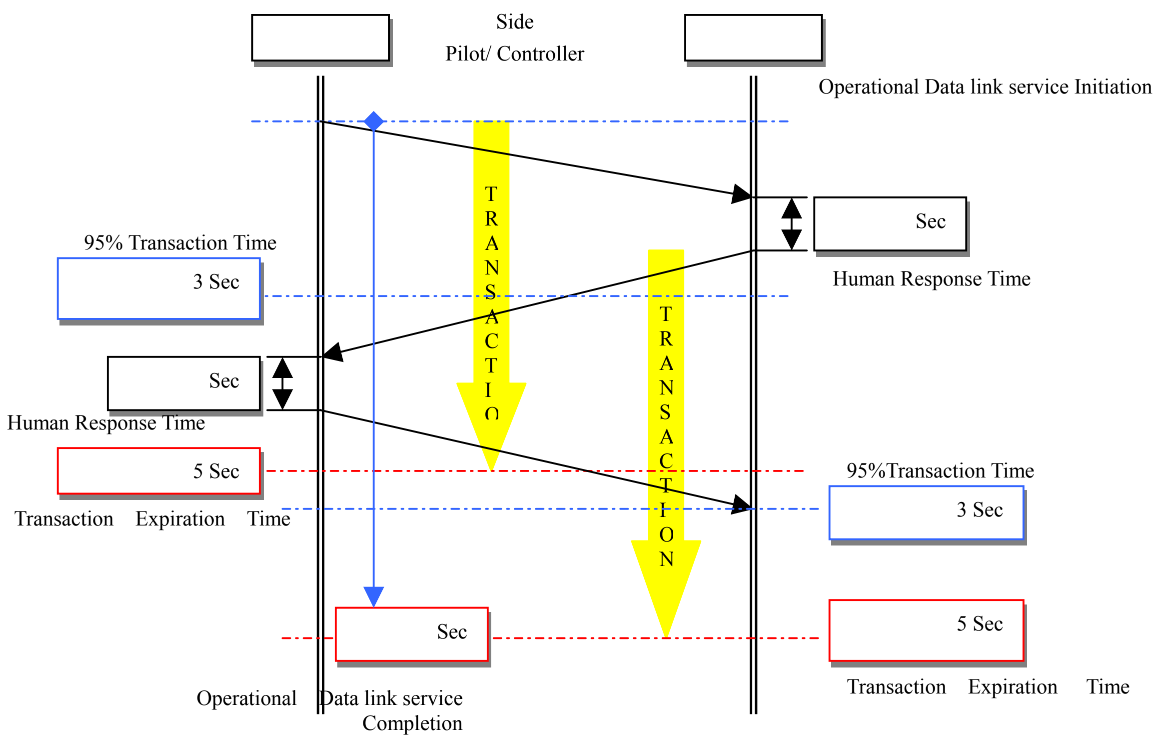


Services	Transaction (TT 95)	Expiration (ET RCP)
Emergency Communications Services	1 (Immediate)	1 (Immediate)
Proposed RCP Values	3	5

Scenario 5.2: Aircraft experiences engine failure after takeoff while under departure control

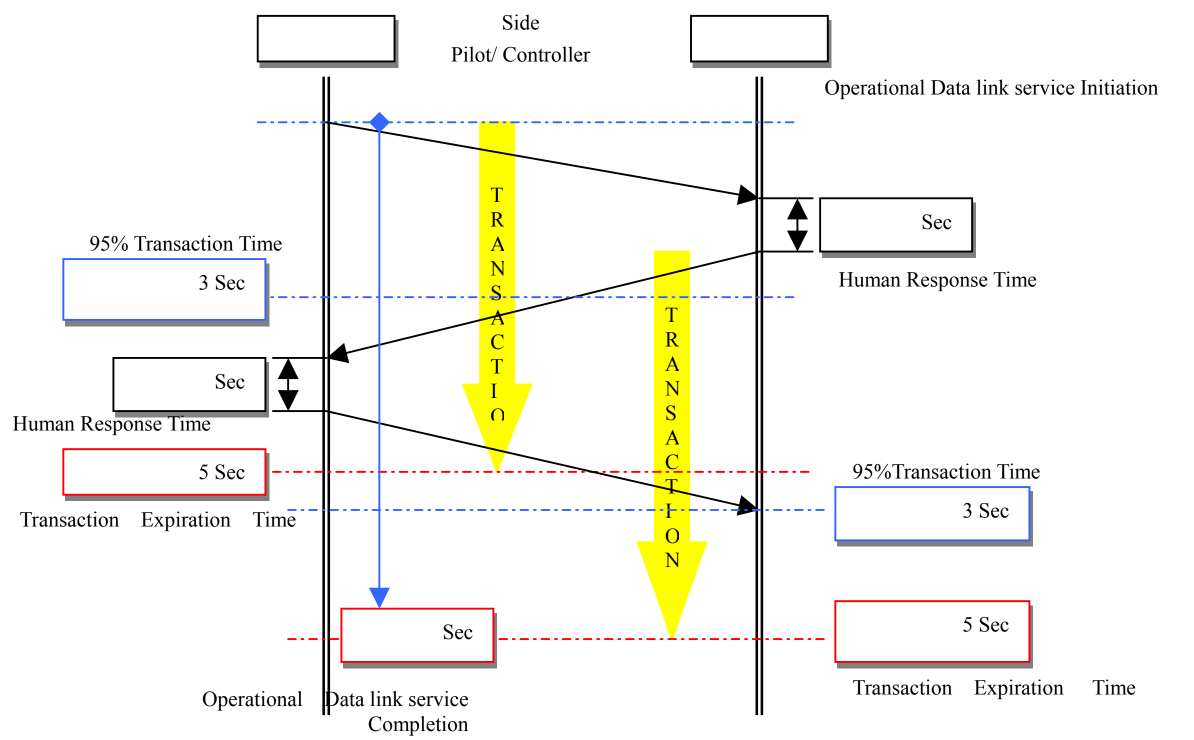
Pilot has just checked in with departure control after takeoff while flying a departure procedure which will take the aircraft over steeply rising terrain. The aircraft experiences a severe compressor stall and flameout on the number 1 engine. Pilot initiates a right turn toward North to avoid terrain then communicates intentions to ATC.

Pilot:	ATC:
Informs ATC of Emergency and turn to avoid terrain	
	Acknowledges receipt and clears aircraft to specific heading to ensure terrain separation
Acknowledges receipt	



Services	Transaction (TT 95)	Expiration (ET RCP)
Emergency Communications Services	1 (Immediate)	1 (Immediate)
Proposed RCP Values	3	5

Scenario 5.3: Emergency Descent		
	Aircraft encounters an explosive decompression while flying at FL 370. The pilots initiate emergency descent procedures and begin descending then communicate that they are descending to ATC.	
	Pilot:	ATC:
	Informs ATC of emergency descent and present altitude passing	
		acknowledges receipt and provides minimum safe altitude with local altimeter setting
	Acknowledges receipt	



Services	Transaction (TT 95)	Expiration (ET RCP)
Emergency Communications Services	1 (Immediate)	1 (Immediate)
Proposed RCP Values	3	5

3. Technical Performance Requirements

The following description of 'Technical Performance' is extracted from the document [7].

3.1 Transit Delay

$TD_{95} = T_{air} + T_{csp} + T_{gnd}$

3.1.1 Transit delay TD_{95}

The transit delay, TD_{95}, is defined as the 95% one-way end-to-end transfer delay. It refers to the period, elapsed from the time at which the originating user hits the send button until the time the transmitted information has been received by the intended recipient and been found suitable for further processing and/or display to the responsible person.

Table summarises the operational performance requirements for the transit delay for each of the data link services.

The values are expressed in seconds.

Table 1: Transit delays

Service	DLIC	ACL	ACM	DSC	DCL	D-ATIS
TD_{95}	6.5	6.5	6.5	90	11	24

Allocation of transit delay, availability and continuity

The transit delay is allocated to three domains: Airborne, CSP and Ground.

Note: The Ground Systems boundaries are the controller HMI and the access point to the CSP segment.

The CSP boundaries extend from the acces point of the Ground System to the tip of the aircraft antenna. The Airborne Systems boundaries are the pilot HMI and the tip of the aircraft antenna.

$$TD_{95} = T_{air} + T_{csp} + T_{gnd}$$

3.1.2 Airborne Domain/Airborne Delay

For a downlink transmission, the airborne delay starts when an aircrew action or an automatic trigger is detected. The airborne delay ends when the airborne system (antenna) emits the message to the communication domain. For an uplink transmission, the airborne delay starts when the communication domain emits to deliver the uplink message to the airborne domain. The airborne delay ends when the message is available at the HMI or to the end system automation.

The airborne delay, TD_{air}, shall be 2 seconds for the ACL and ACM service.
T_{air} for 95% of the total volume of ACL and ACM messages shall be 2 sec.
Note: T_{air} for DLIC TBD

The airborne delay, TD_{air}, shall be 2.5 seconds for the DSC, DCL and D-ATIS service. T_{tair} for 95% of the total volume of DSC, DCL and D-ATIS messages shall be 2.5 sec.

Service	DLIC	ACL	ACM	DSC	DCL	D-ATIS
TD_{air},	-	2	2	2.5	2.5	2.5

3.1.3 CSP Domain/ CSP Delay

For a downlink transmission, the CSP delay starts when the airborne domain emits the message to the CSP domain. The CSP delay ends when the network modem or adapter attempts to deliver the message to the Ground Domain.

For an uplink transmission, the CSP delay starts when the Ground Domain attempts to deliver the message to the network modem or adapter of the CSP domain. The CSP delay ends when the CSP domain attempts to emit the message to the Airborne Domain.

The CSP delay, TD_{csp}, shall be 3.5 seconds for the ACL, ACM, DCL and D-ATIS service.
Note: T_{csp} for DLIC TBD
T_{csp} for 95% of the total volume of ACL, ACM, DCL and D-ATIS messages shall be 3.5 sec
The CSP delay, TD_{csp}, shall be 60 seconds for the DSC service.
T_{csp} for 95% of the total volume of DSC messages shall be 60 sec.

Service	DLIC	ACL	ACM	DSC	DCL	D-ATIS
TD_{csp}	-	3.5	3.5	60	3.5	3.5

3.1.4 Ground Domain/Ground Delay

For a downlink transmission, the Ground delay starts when the CSP domain attempts to deliver the message to the Ground Domain. The Ground delay ends when the information is available to the controller or available to the system automation.

For an uplink transmission, the Ground delay starts when a controller action or an automatic trigger is detected. The Ground delay ends when the Ground domain attempts to deliver the message to the CSP domain.

The ground delay, TD_{GND}, shall be 1 second for the ACL and ACM service.
Note: T_{csp} for DLIC TBD
T_{GND} for 95% of the total volume of ACL and ACM messages shall be 1 sec.
The ground delay, TD_{GND}, shall be 27.5 seconds for the DSC service.
T_{GND} for 95% of the total volume of DSC messages shall be 27.5 sec.
The ground delay, TD_{GND}, shall be 5 seconds for the DCL and D-ATIS service.
T_{GND} for 95 % of the total volume of DCL and D-ATIS messages shall be 5 sec.

Service	DLIC	ACL	ACM	DSC	DCL	D-ATIS
TD_{GND}	-	1	1	27.5	5	5

3.2 Other Parameter Values

4. Summary

The document collected the RCP materials from various documents.
As a summary, it can be stated that

- The communication services in the categories 'Planning Communication' and 'Strategic Communication' in [6] and the communication services in [7] are the potential uses of data communications and the RCP timing values in the data communication environment can be proposed as above.

- The communication services in the category 'Tactical Communication' in [6] can be adapted in the data communication environment by a specific airspace in the region, and it has to be discussed by the concerned States.

- The communication services in the category 'Communications Management' in [6] need further studies, because of the operational aspect in the integrated voice/data communications. The level of the RCP is similar to the 'Tactical Communication' in [6].

- The communication services in the category 'Emergency Communication' in [6] may not possibly be used in the data communication context in near future.